


MANUAL OF  
RAILWAY STATISTICS

GEORGE L. BOAG

LONDON  
THE RAILWAY GAZETTE





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FOUR SHILLINGS NET.

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LONDON:  
THE RAILWAY GAZETTE,  
QUEEN ANNE'S CHAMBERS, WESTMINSTER.

1912.

132389  
14/4/14





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## INTRODUCTION.

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IN offering this manual to railway executive officers at home and abroad, the author (who is a practical railwayman, with experience in four different countries) disclaims any pretensions to originality, but has rather endeavoured to furnish a recapitulation of the different statistical units in common use, with suggestions as to economical methods for their preparation. Opinions differ as to the merits of a control exercised by means of statistical units, some of which cannot be available until some considerable time after the period to which they relate, but, while it is admitted that no average figures can properly replace a close personal attention to daily operations, this is often quite impossible to the head of a large department, and he must have at his command some comprehensive measure of the work of his assistants. The nature of such a measure will vary with the character and scope of the railway, and it is hoped that this little work will furnish, if not the unit best suited to each particular case, some idea of how such may be compiled. More especially abroad, where there are no facilities for reference to libraries, or to friendly colleagues, the suggestions given may be useful to those who require to centralise masses of figures, which tend in detail to confuse rather than to inform. Reprints of the Report of Sir Thomas Rees Price to the Railway Congress, and the Railway Accounts Bill of 1911, are appended, and it is hoped that the reproduction of these documents in a convenient form will help towards the much-needed Standardisation of Railway Accounts and Statistics.





## CHAPTER I.

### THE USE OF STATISTICS.

Some form of statistical measurement of receipts has probably been used since the very beginning of railway working. With the natural growth of business, however, it became increasingly difficult to keep distinct accounts of working on different trains and sections, and a series of average figures has been gradually evolved. These averages, or statistical units, are calculated to show the results of the working of a number of trains or vehicles in a single figure which shall convey the information required without recourse to a mass of detail. A list of the wagons loaded out of a busy goods station in a day, for example, would simply form a confused row of cyphers, but the sum of all the loads divided by the number of wagons gives in one figure the kernel of the information afforded by the list. This then is a "statistical unit" (the "average starting load.") The next step, and indeed the principal use of such an average, is to compare it with the similar figure for the previous day or days. The list of wagons could not easily be so compared, even though time allowed. When an average is obtained for a number of days or months, the figure is adopted as the standard, and the energies of the executive officer will be directed towards improving on the standard.

There are still people who distrust average figures, and who prefer to work on "rough ideas," perhaps derived from something like the aforesaid list of wagons, or from a daily inspection of warehouse and yard. Control by personal observation is admittedly most efficacious, but the busy superintendent or agent cannot be outside all day and every day, and average figures are therefore indispensable. Then again, there is the old grumble of "red tape" when statistics are mentioned. As a matter of fact "red tape" is often nothing more or less than honest system, and to sneer at it betrays the casual man's dislike of order and regularity, and his fondness for "rule of thumb" methods and "rough ideas."

On the other hand, the student is warned against the indiscriminate conclusions which may be hastily drawn from a superficial inspection of statistical units. He should understand the method of their compilation, the classification of the transactions going to make up the totals on which the average figures are based, and the defects inherent in compound units composed of a number of varying factors. In a few words the statistical unit intelligently applied is a very valuable instrument, but it is necessary to exercise the greatest care in its use, and conclusions should only be drawn from the indications given by several units used concurrently.

The recent report of the Departmental Committee, appointed by the British Board of Trade to make inquiries into the form of railway accounts and statistics, is an outcome of the general feeling existing in England for some years past that the statistics published by the English railways are not sufficiently comprehensive. The Committee, in the course of its deliberations, heard and discussed evidence from many leading railway officials. One of the conclusions arrived at may be quoted: "The statistical returns at present furnished by railway companies to their shareholders under the Act of 1868 are very meagre . . . These returns do not appear to be framed upon any definite system, and the information which they contain is very incomplete." The Committee finally recommended the adoption of a uniform set of accounts and statistics, and it is to be hoped that the manifest advantages of standardisation, both in the system of statistics and in the form of accounts, will be recognised by the great English companies. The Committee was divided in opinion on the subject of the ton-mile and passenger-mile, with their corollary statistics, and it was not considered desirable to recommend the compulsory publication of these units in view of the opinion expressed by the majority of the general managers in Great Britain against their adoption. The report carries two reservations, one signed by the three representatives of the railways, dissenting from the favourable view of an extended use of statistics, expressed in the report, and the other subscribed to by Messrs. Acworth, Paish and Peel (who represented the van of the reform party), not only recommending a schedule of additional statistics, but urging the compulsory publication of ton and passenger-miles. A summary of the report is printed in the *Railway Gazette*, page 849, Volume X.

Whatever be the eventual effect of the painstaking work of the

Committee it is evident that a greater interest is now being taken in statistics, and the present work is intended to meet to some extent the demand for information as to the compilation of the statistical units which it may be confidently prophesied will become in England as generally used as they are on railways in other countries.

Perhaps no single feature of railway operation, unless it be that closely allied one of rates and fares, has given rise to more discussion than that of the use of statistical units for the control of train working. Every responsible railway officer has his own idea as to the best methods of securing economy in operation, and nearly every administration consequently prepares a different set of statistics for this purpose. In the case of State-owned or subsidised railways, such as those of India and Australia, a statutory form of statistics has been laid down, and there is a certain uniformity in the periodical figures published. The same uniformity occurs to a large extent in Continental countries, where there is a large degree of Governmental control and inspection, and in the Argentine where the form of accounts of many of the principal railways is derived from one original model. There is always however a divergence in practice and the published statistics are not invariably those used by the executive staff for the direct control of working.

Whatever system be used, the object is the same. A railway is usually said to manufacture and sell transportation, and like any other manufacturer it requires to know the cost of what it sells in order to measure its efficiency and prepare its rates. It has been said that the measure of efficiency is the amount of return produced on the capital employed, but the fallacy of this is shown by the example of a concern that is over-capitalised, requiring much larger net earnings on a given amount of business. A dividend alone therefore, however desirable, is not the only measure of economical working. In other words, it is not sufficient to impugn the management of a railway on the simple fact of its inability to produce a dividend, without taking into consideration the conditions affecting its operations; nor is it sufficient to accept as an indication of efficiency or otherwise the ratio of working expenditure to gross receipts, since the expenditure may be burdened with charges which do not arise out of the actual cost of working, such as interest on loans, reserve funds, &c. Or the administration may be bound down by inadequate maximum rates which limit receipts to a figure that cannot

fully remunerate the work performed and the obligations contracted.

The "train-mile" is the basis most generally used, especially in England, where this is practically the only statistical unit of comparison published by the railways under the present statutory form of accounts. Certainly the train-mile is a more reliable unit than the ratio of expenditure, and it is not sufficient to dismiss it as unpractical in face of the fact that the majority of the managers of railways in Great Britain, and some of those in India and elsewhere, maintain their faith in its reliability. At the same time it is scientifically defective as a unit. The railway sells transport, and receives its earnings in return for the carriage of certain weight a certain distance. How it carries the weight is no concern of the trader who purchases the transport, or whether it be carried in one or several trains. "The intervention of a train for the purpose of the conveyance is, theoretically, no necessary part of its fulfilment."\* The defect of the train-mile is that it is not a complete figure; a train may consist of 5 wagons or 50, of 50 tons or 500 tons, and may convey furniture or coal. An improvement in working, for example in the better loading of wagons, might show an increased cost per train-mile, since the expenditure would be divided by fewer train-miles. Of course, if rates were maintained the receipts per train-mile would rise in a corresponding ratio, but the unit is none the less unsuitable for comparison, whether the comparison be made between two individual railways or between two periods. The train-mile is a variable unit and does not represent the same combination of conditions at different periods and in different places.

What is required is a unit which shall represent the work done, not in running a train of unknown composition, but in carrying a given weight a known distance, and this we have in the ton-mile, or for passenger traffic, the passenger-mile. Ton-mileage is the total of the tons carried one mile. It provides a unit comprehending the two factors of the transport sold, *i.e.*, weight lifted, and distance conveyed, and is undoubtedly the most scientifically comprehensive unit that can be adopted; it is indeed the only index which can be truly said to cover in one single figure the summarised result of the actual work of transport. Moreover the ton-mile is the basis of many other average figures, such as average loading per wagon and per train, average receipt, length

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\* R. L. Wedgwood, in "The Economic Journal," March, 1909.



of haul, &c., all of which have their uses. This fact has been often overlooked by railway officers in discussing the value of average statistics. It is not altogether the value of the ton-mile itself that has warranted its preparation, but the other units which form a part of it, or which are derivable from it, and which cannot be produced without it.

Certainly all these are average figures and must be used with caution, but, perhaps, too much emphasis has been laid on the objection to average figures. If the head of a department or general manager could possibly watch every detail of the service, he would not require those details to be summarised, but he cannot, and he must therefore fall back on averages; the larger the concern the more concentrated his averages. The manager of a "one man" railway 50 miles long, with 10 trains a day, can perfectly well maintain a daily watch on his train loads, &c., but on a larger railway, not only would it be impossible for the general manager to scrutinise such a large amount of detail, but it would be a waste of valuable time for him to attempt it. One is reminded of the president of an American railway who, in explanation of the entire absence of the usual litter of papers on his office table, said that his company paid him to think and not to work. One of the English methods quoted in the evidence before the Board of Trade Committee on Railway Accounts, was a form showing the number of wagons less than the authorised load on every train on a given section for every day of the month. Now this form is very useful but it contains an enormous mass of detail if it is intended to be read through by the general manager or his busy assistants. Some means ought to be possible of giving the gist, the essence, of such a form, in an easily checked total. A mass of figures generally has the effect of confusing the reader; the mind is temporarily glutted as it were, and the true significance of the net result is overlooked. A statement such as the one referred to is obviously a useful one for the district superintendents, but it could also be checked weekly or monthly by the general manager through the medium of the "traction ton-mile" which, as distinct from the traffic ton-mile, is available within a few days after the end of the period it relates to, and can moreover be taken out for each train separately.

The passenger-mile is not capable of such a wide range of application as the ton-mile, and its uses are limited, and depend largely upon local circumstances. If a railway, as in England, has to run passenger trains for competitive or other reasons which

render necessary a non-productive service, the passenger-mile in itself is not of much assistance. Like the ton-mile, however, it must not be considered on its own merits, but rather in the light of the value of the other units obtainable from it.

The cost per ton-mile and per passenger-mile is again a very debatable subject. It is true that any division of the cost of the numerous services which are common to the use of both freight and passenger traffic must be largely estimated and even empirical, but if the same formula be used from year to year, the inaccuracy is obviously present to the same extent in the figures compared.

While the figure of cost, therefore, is hardly suitable to compare one railway with another, owing to differences in the allocation followed, it is a reasonably exact figure for comparison between two periods of working on the same line, or on the same section of a line.

No consideration of these statistics would be complete without mention of the effect of their use on the staff. In fact it is possible that in many cases, even were the returns filed away in the management office without attention, they would already have achieved their object. If a district superintendent be made to submit an average figure of working, whether it be daily, or weekly, or monthly, and whatever form the unit may take, and if he be made to compare it with the previous period and the same period in the previous year, and to explain the increase or decrease, it is bound to make him think and study his district. Glaring faults are obvious at the time, to the travelling inspector or stationmaster, but insidious faults go on for long unperceived. It is the insidious faults which affect average results, and which may therefore be detected at headquarters when they have passed unnoticed by the whole of the outside superintending staff.

## CHAPTER II.

### TRAFFIC STATISTICS (RECEIPTS).

*Ton-mileage*—Ton-mileage is weight multiplied by distance, and the ton-mile is 1 ton carried 1 mile, or in other words the tonnage carried multiplied by the miles it has been hauled. For example, 10 tons hauled 10 miles are equal to 100 tons carried 1 mile,  $10 \times 10 = 100$ , or 100 "ton-miles." The two factors of weight and distance are thus reduced to one compound unit. The combination of the two factors represents the work done, as in the case of a somewhat similar compound unit, the "foot-pound" in physics. There are many other definitions of the ton-mile, but the above is, perhaps, the most simple way of describing it. It is necessary thoroughly to understand the nature and use of this unit, as there are many other statistics derived from it and used in combination with it.

There has been a vast amount of discussion of late years as to the value of ton-mile statistics, and a large part of the evidence taken before the Board of Trade Committee on Railway Accounts and Statistics turned on the applicability, or otherwise, of these statistics to English railways. Practically all the railways in the world, outside the British Isles, compile ton-mile statistics. The one exception in England is the North-Eastern, where ton-miles have been compiled now for some 10 years. The North-Eastern officials have repeatedly pronounced in favour of the use of ton-mile statistics. Mr. Wedgwood says, "It seems impossible to come to any other conclusion than that for railway work the units, both of product and of work done, must in theory be the ton-mile and the passenger-mile." Sir George Gibb in his evidence before the Board of Trade Committee said: "The opponents of ton-mile statistics seem to me to suggest for them uses and merits which they cannot possess and which, so far as I am concerned, I have never claimed for them in anything I have said or written on the subject, nor have I ever made the slightest approach to a suggestion that ton-mile statistics could or should displace other working statistics. Ton-mile statistics are, in my judgment,





*Passenger-Mileage.* — The “passenger-mile” is one passenger carried one mile and the computation of passenger-mileage is exactly similar to that of the ton-mileage. Ten passengers booking to a station 10 miles distant are equal to 100 passenger-miles. Passenger-mileage is therefore the number of passengers carried one mile.

In the references above to the value of ton-mile statistics these have been generally understood to include passenger-mileage. Nevertheless, a distinction must be drawn between ton-miles and passenger-miles, as it is admitted that the latter have not the same sphere of usefulness as the former, nor the same amount of reliability. Booked trains have often to be run whether there be a paying load of passengers or not, and therefore the passenger-mile is not always the true criterion of the work done. One of the arguments in favour of the train-mile is, that as regular trains have perforce to run, with or without a paying load, the train-mile is the measure of service performed, which is true to this extent of passenger traffic, that it is possible for an advertised train to run entirely without passengers, and the passenger-mileage would be *nil*, whereas the train-miles run would still figure as a record of the service, independently of the number of passengers, which it is often impossible for the administration to increase. The case of a train running without any passenger-miles is of course an exaggeration, but it also furnishes an answer to the train-mile argument, for just as the train-mile counts independently of the load of the train so does it fail to give an exact indication of the useful work of that train. The example serves to emphasise the necessity for the concurrent use of two or more statistical units, in order to obtain an intelligible reading of the results recorded.

*Compilation of Ton and Passenger-Mileage.*—A striking feature of the discussions that have taken place on this subject has been the extraordinary difference in the opinions expressed of the cost of compiling ton-mile statistics. One of the principal objections of the railway Companies in Great Britain to the adoption of ton-miles is the cost of compilation, which was first estimated at £15,000 per annum for the North-Western alone. Fortunately there is the experience of the North-Eastern, to provide exact figures. Their statistics office costs altogether £3,000 a year, of which £1,000 are directly attributable to the compilation of ton-mileage. A similar figure is quoted for the East Indian Railway, and also for the Grand Trunk Railway of Canada. There

appears to be no reason why other railways should have to exceed this figure to any great extent, and in the case of the North-Eastern it only forms '07 per cent. of the total goods and mineral receipts.

The principal difficulty in the way of ton-mile statistics in England is the large proportion of traffic running over other companies' lines, and this is always quoted as an almost insuperable difficulty in the way of compiling ton-miles. It is certainly an important factor, as in no country in the world is there such a complication of running powers, joint lines, and other special arrangements for exchanged traffic, as in Great Britain. This admittedly will make the compilation of ton-mileage more difficult and more costly, but probably not to the extent that has been stated. The cost of computing the ton-mileage of the "through-through" traffic (*i.e.*, traffic passing over an intermediate line from and to foreign stations beyond its junctions) by the Railway Clearing House, has been estimated at from £3,000 to £4,000 a year, say £250 a year each for the 15 principal companies. Probably the companies would do it much cheaper themselves.

There is an important point in connection with all these statistics, and which especially affects the cost of compilation of ton-mileage. It seems to have been taken for granted in England that the ton-mileage should be compiled in the accounts office from duplicates of the invoices or from the abstracts sent in monthly from the stations, and it would appear that this is the method followed in India, and on the North-Eastern, but on the Continental lines a large part of the work is done by the stations. There seems to be no reason why it should not be done in England in the same way. As each consignment is invoiced the shipping clerk multiplies the weight by the distance, and inserts in a column provided for the purpose on the invoice the corresponding ton-mileage. These ton-mile figures are abstracted at the same time as the charges, and the totals of the forwarded abstracts give the total ton-mileage between the forwarding point and the other stations to which goods have been shipped.



mileage, leaving only the grouping of the abstract totals to be completed at headquarters. The heaviest part of the work is distributed in this way between a very large number of clerks. At the small stations the extra work involved is negligible, because the stationmasters and clerks generally have plenty of time to spare. At large goods depôts the addition of a multiplication sum to every entry would not be welcomed in the shipping office, and it might even mean an additional junior clerk to every 20 invoicing clerks or say five per cent. increase of staff. "Ready Reckoners" would be used, in something the same form as the "smalls" scale, except that small fractions of hundredweights and miles would be ignored. There is often a great press of work at a busy station, in the short time between the arrival at the station of the heavily laden drays of goods from the town, and the despatch of the wagons by the night goods trains, and there is not much time for extra refinements in the office, if the invoices are to be completed in time to go with the trains, but where there is not time for the ton-mileage to be calculated, it can perfectly well be added to the office copies on the following morning, before these are sent to the accounts office for posting and abstracting.

The ton-mileage is abstracted at the same time as the weight and charges and the summaries are provided with suitable columns. If "commodity" ton-miles are taken out the station will be required to forward a separate statement in cross-check form, the commodities along the top and the stations down the side. At the audit office similar summary books will be used, one for each district, or section of the railway. For a section containing 25 stations the book will have 25 lines, and where 50 commodities are ton-miled, it will have 50 columns; supposing all the stations to have had transactions in 50 commodities, there will be  $25 \times 50 = 1,250$  entries to make and 50 columns to add up, and if there be 10 such sections on the whole system there will be 12,500 entries and 500 columns to add. The entries would be made at the rate of about 10 a minute, say three men-days' work. The adding ought to be done easily at the rate of one column per minute, say two men-days' work. Then there would be the foreign mileage to summarise and add, and statements to prepare and send to other railways or the Clearing House. Also occasional checks would be made of the station totals, by means of recalculations of the mileage shown on the abstracts. Afterwards the final summaries would be prepared for presentation to the general manager.

The operation may be further simplified by ton-miling the totals only of each abstract ; *i.e.*, as a separate abstract is made for each station to which goods are forwarded, the total tonnage for the month is multiplied by the known distance and the resultant total is the ton-mileage performed between the two stations. This total is inserted in the abstract and the summarising at Head Office becomes a comparatively simple matter.

To complete the ton-mileage of everything passing over the Company's lines, or hauled by the Company's engines, special arrangements would have to be agreed on between the Companies for the ton-miling of through-through traffic, that is, traffic passing from one railway to another, over the line of a third company. For mineral traffic, as the settlements are made by the Companies themselves, on a mileage basis, there would be no difficulty and the totals would be obtained from an extra column in the monthly statements of settlements, summarised afterwards on a special form. The ordinary merchandise offers greater difficulty. There would be two ways of obtaining the ton-mileage of through-through goods, either from data supplied by the Clearing House, or by a series of statements furnished by the stations and ton-miled in the audit office according to the proportionate mileage fixed for each route. The former is apparently the method adopted by the North-Eastern, although no special information is said to be required, and the mileage is extracted from the ordinary settlements.

The other method would be that of a special form from the stations to audit office, "forwarded and received traffic passing over two or more foreign lines." Such a statement would simply show class of merchandise, destination, route, and weight, and would be abstracted each month at audit office, after which a note would be forwarded to each of the other Companies interested, reporting the "number of ton-miles of.....Company's," "merchandise hauled by.....Company's engines during "....." Possibly this information would be more satisfactorily obtained from the Clearing House, whose business it is to make proportionate settlements. A large number of settlements are allocated on a mileage basis, and with these there should be no difficulty as the weight could be apportioned at the same time as the money ; the "light" traffic, which is distributed *pro rata* to the receipts from the "heavy" could not be ton-miled by the Clearing House, but as this only forms about 5 per cent. of the total heavy traffic dealt with by the Clearing House the tonnage



might be distributed *pro rata* in the same way as the money without seriously affecting any Company's total ton-mileage. It is to be understood that this is only for through-through traffic. There would be no necessity whatever to ask the Clearing House for information on ordinary interchanged traffic, which as explained above would be ton-miled by the receiving station.

Much of the foregoing is equally applicable to passenger-mileage, the figures being inserted in an additional column on the monthly "classification of passengers" statement, and separate forms being sent in for tourist and season bookings. The latter would be computed in audit office on a fixed basis, as is done in India, of so many journeys per month. Here again the interchange bookings offer considerable difficulty, and even more so than in the case of the goods traffic, as in a large number of cases, a ticket gives an option between two or more routes, and there is no record of the actual journey. Such tickets, however, form a very small percentage of the whole of the bookings, and even if computed on arbitrary lines the possible error would be small.

Under the Indian system the whole of the passenger-miles are not multiplied out separately, but the total receipts from ordinary bookings are divided by the fixed mileage tariffs for each class, and the computed "unit" or passenger-mileage is thus obtained. Thus, if total third-class ordinary receipts amount to £10,000, at a fixed rate of a penny a mile, obviously the corresponding number of ordinary third-class passenger-miles is 2,400,000. In this way the great majority of the bookings are reduced to mileage in a single operation, and the reduced fares only remain to be multiplied out in the same way but in a greater number of groups. For example all the "fare and a quarter" cheap return bookings in England would fall into one group, to be divided by '625 of the fixed ordinary rate per mile. Season tickets are reckoned as equivalent to 40 single journeys per month. The compilation of passenger-miles by this method, if the percentage of reduction in rate for different groups of cheap bookings be known, is a comparatively simple matter.

It must be remembered that while absolute exactitude is not to be hoped for in ton and passenger-mileage, such slight inaccuracy as may result from the wrong routing of a few score passengers or a few hundred tons, even though such inaccuracy be undiscovered for months, would not affect the ultimate figures appreciably.

This may be shown by an example. The North-Eastern, in 1907, earned in freight receipts £6,792,078, or say 1,630,098,720 pence, and in the same year their ton-miles amounted to 1,483,904,522. The division of the pence by the ton-mileage gives the freight receipts per ton-mile. Now it will be found that an error, or accumulation of errors, amounting to 10,000 ton-miles, will only affect the sixth decimal figure of the result. The argument, therefore, that ton-mileage cannot be reliable on account of the discrepancies that must occur by reason of wrong route apportionments, station inaccuracies, and clerical mistakes, has not much force, but on the other hand the question naturally suggests itself, what is the use of a statistic which is not exact within tens of thousands? The answer is that the degree of accuracy is known, and in all properly used statistics it is taken into account. To have such figures absolutely accurate one would have to go into questions of fractions of miles and pence. The published receipts themselves are not absolutely "accurate" since there are many settlements, overcharges and undercharges, adjusted in subsequent months or years, nor can it be said that train-miles represent the exact distance run by the trains. Such differences as there may be overstated or understated in the ton-mileage (and these should certainly not reach to the thousands figure) will tend largely to counterbalance each other and the excesses will cancel the shorts. Any very extraordinary difference will affect the final figure, and will cause investigation.

Another factor which has been held to invalidate the use of ton-mile statistics is the terminal. The same amount is added on account of terminals whether a consignment be invoiced 10 miles or 100 miles, and is therefore distributed in unequal ratio to the distance, *i.e.*, a consignment of one ton carried 100 miles does not cost the company as much as 10 separate consignments each carried 10 miles. If the terminals are 1s. 6d. at each end, the former will be charged with 3s. for 100 ton-miles, and the latter 30s. for an equal ton-mileage. Or again, foreign received traffic only pays one terminal to the receiving company, and "through-through" traffic none at all. The safeguard in this case lies in the stability of the average haul. The average distance all the consignments are carried varies very little from year to year, and the proportion of the terminals charged to long and short distance traffic is therefore practically constant. Or if required it is perfectly possible to deduct the total amount of terminals, (which can be estimated with a fair amount of accuracy) from the total

receipts, which then divided by the ton-mileage will give the absolute receipt for transport only.

Passenger-mileage is not affected by this question of terminals to any appreciable extent.

There is still another factor which is ignored by the ton-mile unit and which is said to militate against its usefulness, and that is the question of the cubic capacity of wagon stock. The ton-mile takes into account the weight, but if a given traffic largely consists of furniture for instance, the wagons will be loaded up to their capacity and will still run with light loads; in this case no statistics will help, and the proportion of such traffic only affects the results derived from ton-mile statistics; it does not invalidate them. The average load of a railway carrying a large percentage of light traffic will be low, as compared with that of another carrying a heavy mineral tonnage, but this will be perfectly explainable.

To complete the ton-mileage of the whole of the traffic, there remains the live-stock and parcels traffic. Live stock is generally computed on an average scale. The North-Eastern use the following table, the weights calculated in decimals of a ton:—horses '65, ponies, &c., '325, cattle '42, and a smaller figure for calves, pigs, sheep and goats down to geese, which are '005 of a ton. These figures will of course vary in different countries; in India they are as follow:—

Horse, pony, or head of cattle...	...	...	...	0.25 tons
Head of sheep, goats, &c.	...	...	...	0.025 tons

and where the mileage of live stock cannot be ascertained receipts are reduced to ton-mileage at the average rate per ton of general merchandise. The same standing instruction in the Indian Code Book provides that the ton-mileage of parcels should be given approximately, on the best available data, if it be found expensive to give accurate figures. The French system is more definite if more arbitrary. All the coaching traffic, other than passengers, and including parcels, mails, luggage and live stock is converted into equivalent goods ton-miles, with the following formula:—

- A.—Total receipts from parcels, luggage, mails, live stock, and miscellaneous.
- B.—Total goods ton-miles.
- C.—Total goods receipts.
- D.—Equivalent ton-miles.

$$D = \frac{A \times B}{C}.$$

Having now the mileage of the whole of the traffic, the freight in the shape of goods ton-miles, the passenger traffic in passenger-miles, and the parcels, live-stock and miscellaneous in computed ton-miles, the next process is to express the whole in a common denominator. In other words to reduce the whole of the ton and passenger-mileage, to a common total, including the whole of the transport effected, in all classes of traffic, and covering both the weight carried and the distance hauled. To begin with, the goods ton-mile, within the limits laid down in the preceding paragraphs, is an exact figure, since the true weight is known and the true distance. Live stock can also be ton-miled with a comparatively small margin of error. Light traffic such as parcels and miscellaneous has been computed *pro rata* to the goods receipts, and although admittedly this can only be approximate, it forms too small a proportion of the total for such small error as there may be to seriously affect the whole. There remains the passenger-mileage. The goods ton-miles, the live stock ton-miles and the estimated ton-mileage of the light traffic are added together, to produce the total ton-mileage of all traffic except passengers. The passenger-miles obviously cannot be added to the rest, as the two units are quite distinct in their nature. It is therefore necessary to reduce these passenger-miles to terms of goods ton-miles, an operation for which there are two formulæ. The simpler is that in use in India, which is as follows, and includes units other than passengers carried in passenger trains :—

1 first-class passenger (with free luggage)	...	...	...	0·10 tons.
1 second-class " " " "	...	...	...	0·08 "
1 third-class " " " "	...	...	...	0·06 "
1 carriage (average two and four-wheeled)	...	...	...	0·34 "
1 horse ... ..	...	...	...	0·44 "
1 dog ... ..	...	...	...	0·01 "

The second formula is used in France and is based on the theory that the cost of carrying one passenger one mile is equal to that of carrying one ton of goods one mile. To arrive at this theory it is presumed :—

(a) That the transport of a passenger costs the railway ten times as much as that of an equivalent weight of ordinary slow freight, and

(b) That the average weight of a passenger, with his free luggage, is equal to one-tenth of a ton ; therefore,

(c) The transport of a passenger one mile will cost as much as the carriage of one ton one mile.\*

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\* Charles Baum, *Resultats de l'exploitation des Chemins de fer Français*, 1877.

The soundness of this argument may be open to question, but it is not proposed here to enter into a discussion on the subject of its merits and defects; it is simply laid before the student as an example of actual practice.

The formula is as follows :—

Where A = total expenditure.

B = gross receipts.

C = passenger receipts.

D = passenger-miles.

$x$  = computed cost of transporting one passenger one mile.

E = equivalent ton-miles.

$$\frac{A \times C}{B \times D} = x, \quad \text{and} \quad \frac{C}{x} = E.$$

It will be seen that the computation is based on the relation of the receipts from passengers to the gross receipts and the total expenditure. A simpler way of expressing the formula is as follows:—The equivalent ton-miles bear the same ratio to the passenger-miles as the total expenditure to the gross receipts, a simple rule-of-three sum—the gross receipts divided by the expenditure and multiplied by the passenger-miles giving the equivalent ton-miles.

The sum of the goods ton-miles, the ton-miles for parcels, cattle, &c., and the equivalent ton-miles for passengers is the total ton-mileage for all traffic.

“*Commodity*” ton-miles are freight ton-miles subdivided to show the extent of traffic in the different classes. The extent of the subdivision depends on the nature of the business. The first separation is obviously that of the goods and mineral ton-mileage, and as this separation is already made both in tonnage and receipts there is no difficulty in dividing the ton-mileage. Subsequently the mineral total will be subdivided between coal, lime, and other traffic in classes A and B. It may only be necessary to distinguish one or two commodities. In the mineral classes, or perhaps, in the case of a railway with a very small proportion of this traffic, coal alone would be separated and all other classes would be ton-miled as “Minerals-various.” In the same way goods traffic will be divided up into commodities corresponding to those items of traffic giving the largest percentage of tonnage. Light, or “carted” traffic, would not be subdivided, as many entries are included on one invoice. But grain, timber, heavy machinery,



and similar traffic, which is generally invoiced separately, in fact all traffic shipped in full wagon loads, would present no difficulty. It must be admitted that the compilation of commodity-ton-miles would largely increase the amount of work entailed in the compilation of ton-mileage. The stations would have to send in separate abstracts for each commodity, and summarising at headquarters would be multiplied to some extent, although not in direct ratio to the number of commodities ton-miled. That is, if 10 items of traffic were taken out separately, it would not mean a tenfold increase of work, as it is obvious that there would always be a large number of "nil" returns with corresponding blanks in the summaries. A further sub-division suggests itself. The goods ton-miles may be classified between foreign received, foreign forwarded and "through-through" traffic, and as all this traffic is already abstracted separately, the additional work involved would be slight.

Passenger-miles are capable of being subdivided into first, second, and third classes, reduced fares, workmen's tickets, and seasons. If passenger-miles be compiled at all it will evidently be profitable, even at the cost of the extra labour, to know the average rate, average journey, &c., of the various classes. Care should be taken to ensure double mileage being entered for each return ticket. A passenger with a return ticket should count as two, since he takes two journeys, and occupies seats on two distinct trains, and his mileage will necessarily be that of the double trip. Interchangeability of return route may disturb actual accuracy in this figure, but it may be accepted that return tickets available for return over another company's line will be largely equalised in practice, as otherwise the companies interested would hardly agree to their use. In any case the proportion of the mileage thus diverted will be very small.

While, therefore, the sub-divisions suggested will certainly cost more labour to compile, the value of the statistics is enormously increased by the additional information thus afforded, and where accounts are kept separately for each district or branch line, the advantages attaching to a knowledge of average rate, average haul, &c., on every section of the railway, and to the comparisons thus afforded, are incalculable.

*The use of ton-mile statistics.*—Several conclusions may be arrived at from the preceding paragraph. First, that the ton-mile is the only statistical unit which covers the whole of the service performed, *i.e.*, weight carried and distance run, wherein it is

preferable to the train-mile, which takes no account of weight. Secondly, that the use of ton-mile statistics is practically universal except in Great Britain, where many railway experts disclaim their utility and emphasise the cost of preparation, maintaining at the same time their preference for the train-mile as a working unit. The North-Eastern officers, however, have used these statistics for some years. Thirdly, conditions of railway working in England are different from those obtaining in countries like America and India, and with the very large proportion of interchange traffic, complicated arrangements of joint lines, running powers, &c., the compilation of ton-mileage statistics is not such a simple matter as it is in those countries. Nevertheless it could be carried out in England at a much less cost than is commonly supposed by means of returns of ton-mileage compiled in the stations, so that only the summaries would require to be totalled at head office.

Finally, it has been seen that the ton-mile is a compound unit, made up of an enormous number of transactions, and while one of its principal merits is this summing up of the whole of the work done into one convenient index figure, on the other hand absolute accuracy is impossible, just as it would be impossible to take chains and yards into account in train-mileage, or include pending settlements as exact figures in the total receipts.

The inexactitude is thus admitted, and the sensible person will make allowance for it. He will know from his experience of the traffic what his possible error may be, and according to the importance of the railway he will fix that possible error as being limited say, to the sixth decimal place, and will therefore take into his comparisons only five decimal figures.

All statistics are subject to qualifications, and are profitably used only by persons acquainted with their nature. Sir George Gibb says, in this connection, "The existence of numerous factors in the statistics, all of which must be taken into account, whilst making them more difficult to use, enhances their value in use. Cross lights are obtained, and this interaction of all the various factors in securing the net average results obtainable is realised and measured."\* The same authority uses the analogy of a doctor, who first of all measures the temperature of his patient, and knows from that whether he need go further and investigate the causes of any abnormality.

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\* Minutes of Evidence. Railway Accounts Committee. Q. 9707.

Ton-mileage statistics are not available until some time after the operations to which they refer, but this is not altogether a disadvantage. There are two principal uses for such statistics, to know the state of health, so to speak, of the business in the present, and to govern by means of the results of one year the changes required for improved working in the next. The traffic of most railways is to a large extent seasonal, and it is only with an exact knowledge of average results obtained on a given traffic one year that suitable measures can be taken to deal more profitably with it in the next. It is not intended to suggest here that these or any other statistics are capable in themselves of curing all the ills that railways are heirs to. Extending the analogy referred to above, average statistics may be likened to the clinical thermometer; when the state of the patient is satisfactory there is no variation from the normal, but any rise or fall is an indication of something unusual requiring investigation. The ton-mile figure is not a specific remedy, it is but a diagnosis.

It has been repeatedly stated that the ton-mile figure is in itself but a means to an end, and that it serves as a basis for many other units in conjunction with which it should be used. The practical use of these will now be considered.

*Total tons of freight carried one mile.*—This of course is the total goods ton-mileage. The tonnage of freight carried is not the same thing. A small mineral railway 10 miles long, may show a tonnage of 1,000,000 tons a year, and yet will only have performed the same amount of work as another line 100 miles long with only a tenth of the tonnage. The ton-miles will be the same in both cases. The total ton-mileage is, therefore, the true record of the transport effected. At the same time the total tonnage is not to be ignored; on the contrary, the two units must be carefully watched in conjunction. A falling tonnage with stationary ton-mileage infers an increased average lead, *i.e.*, the tonnage has been hauled a longer distance, and *vice versa*. The tonnage again may show no variation, concurrently with a loss of revenue, which will be explained by the ton-mileage indicating a decrease in average haul.

*Total passengers carried one mile.*—Similarly to the foregoing this unit should be used concurrently with the number of passengers booked, the two figures indicating truthfully the variations in passenger traffic. This indication is extremely useful where passenger-miles are subdivided into ordinary and excursion bookings.

*Total traffic in ton-miles.*—The total ton-mileage of all classes of traffic affords a valuable figure of comparison between one year and another, as whatever the defects of the methods suggested for reducing the different units to a common denominator, such defects are constant from year to year, and do not invalidate the comparison. Moreover, until someone invents a better method reducing the whole of the transport performed to a single composite figure, this unit of equivalent freight ton-miles is the only available one for the purpose.

*Train-miles.*—The train-mile is the most accessible and therefore the soonest available unit. The total of the train-miles is the number of miles run by all trains, during a given period. It may be used in various ways, and may be taken out for each train separately or for each section, or simply divided between passenger and freight services. The total figures may cover a week, a month or a year, as required. In the published reports of practically all railways in England and abroad, the receipts and expenditure are expressed in terms of "per train-mile," and the figures obtained by dividing the total receipts and expenditure by the total train-miles run are used for comparing the results of one working period with the same period of previous years. The train-mile is a unit of distance only and takes no account of weight of trains; it is defective in this important particular, and in any consideration of "per train-mile," allowance must be made for the other varying conditions of working. The train-mile does not fully represent the work done. In England, for example, the number of train-miles run during the last 10 years has steadily decreased, but at the same time there has been an equally steady rise in tonnage hauled. The reduction in train-mileage on the face of it indicates a reduction in the work performed, but the tonnage lifted tells a different tale. This greater tonnage has cost more to haul, and if the expenditure be divided by a lesser train-mileage, the percentage of increase of cost is unduly magnified. If the receipts increase in direct ratio to the tonnage the earnings per train-mile will also increase, but with a decreasing average rate the net earnings per train-mile will be reduced, and here the train-mile ceases to be a true index, for without the ton-miles there is no means of knowing the average rate, or of ascertaining definitely whether a variation in this particular is responsible for the drop in net receipts per train-mile. Another factor is the average lead (*i.e.*, the average distance each ton is carried) which



is again only obtainable from the ton-miles. It is true that the variants, of average receipt and average lead, are reflected in the train-mile figure, but they are not identified in any way ; that is to say, the true reason for a variation one way or the other in the total train-miles, is not shown without reference to the other factors.

To obtain the train-miles the officials in charge of the trains are made to keep a record of the distance they run, and these records are added together in the office when the driver or guard sends in his return. In England the driver submits a weekly statement of both train and engine-mileage. The train-miles are given separately for each day of the week and are divided between passenger and goods traffic (on some railways mineral traffic is also kept separate). On the Indian railways train-miles are recorded by both drivers and guards. The guard enters the mileage covered by his train at the foot of his way-bill and when this is received in the office it is placed with the preceding way-bill for that particular class of train, and the previous total brought forward, and added, a column being provided for that purpose, thus :—

Train-mileage of this train.....	.....
Total of previous corresponding train.....	.....
Total train-mileage carried forward.....	.....

At the end of each week the totals of each class of train are entered into a register which provides the summary for the weekly traffic return (if required) and for the half-yearly report. A weekly return is rendered by the locomotive department to the audit office to be checked against the traffic return of train-miles. On the continent of Europe train-mileage is generally entered by the guards on their way-bills and only the locomotive-miles (and in some cases the gross-ton-miles) are taken from drivers' tickets. This method is probably the most satisfactory and the cheapest, especially if a summary be made on each way-bill as in India, as in this way the figure is available at any moment and can be taken out for separate services or odd periods as required. The check between engine-miles and train-miles is of doubtful utility. The men often run continuously with one class of train, and get to know the mileage so well that mistakes are few. At the same time experience will show the proper ratio between engine-miles and train-miles, and this provides a check against any large error.



Like all other statistical units the train-mile should be used with caution, and it is recommended that no conclusions be drawn from train-mile results without taking into consideration the other figures relating to the same period. In the first place it is of course necessary to subdivide train-miles into passenger, mixed, goods, mineral, and service train-miles, and as each class of train provides a separate guard's way-bill, or is distinguished in the driver's mileage ticket, this offers no difficulty and no extra work. Alongside the classification should be stated the percentage of each class to the total. The reason for the classification is that the different figures are used afterwards in connection with other statistics. On many railways the train-mileage is compiled solely in the locomotive department, but there is no doubt that a better method is for the traffic department to be responsible for the figures. If the traffic officers are to be judged on the results shown by certain statistics they should have the preparation of such statistics in their own hands. Moreover, it is probable that train-miles can be compiled with greater facility and accuracy by the traffic staff, than in the locomotive department. The guard of a train can make up his way-bill on the road between stations; the driver has to do it when he gets back to shed and has cleaned his hands of a first coating of oil. In fact, everything points to the guard as being the more suitable person to conduct the "book-keeping" of the train. The Author actually discovered, on one railway, that the custom was for the guards to write up the drivers' tickets, as well as their own way-bills, and this practice, although quite unauthorised, was "winked at" as it was found that it produced a cleaner and more accurate record. The reason for the compilation of train-mileage in the locomotive department is explained by the necessity for a record of shunting, light, and assisting engine-mileage, which, deducted from the total engine-miles, leaves the net train-mileage, these figures being required for the measure of coal and oil consumption, allocation of mileage premiums, &c. The figures are therefore duplicated where a separate record is kept by the guard, but against this there is the advantage to the traffic staff of having their own set of figures, with added accuracy. This is the more important when it is considered that the train-mile is, as regards distance, a fairly exact figure, whereas a part of the engine-mileage is computed, at so many miles an hour.

Too much importance cannot be laid on the necessity for a careful use of the train-mile. No figures based exclusively on this

unit should be accepted without a consideration of correlative statistics. This is sufficiently obvious when it is remembered that in the train-mile are merged the performances of heavy trains and light, of costly expresses and packed excursions. If the respective proportions of different classes of trains remain more or less constant from year to year there is little variation in the value of the total, but such variation must always be allowed for. Probably at some future date a unit will be introduced, based on the train-mile, but taking into account weight and speed of train, type of engine, and percentage of gradient and curvature of the road.

*Gross ton-miles.*—Ton-miles are the “net” tons of freight carried and “gross” tons are the tons of freight and dead weight hauled, behind the tender, *i.e.*, the weight of the merchandise in the wagons added to the weight (or “tare”) of the wagons themselves. The gross ton-mile therefore is the measure of all the work of actual haulage performed by the locomotives. Part of this work, measured by ton and passenger-miles, is directly productive, and part, consisting of the haulage of dead weight of vehicles, only indirectly productive. But whatever be the ratio of directly productive haulage to the full capacity of the motive power (*vide* “traction ton-miles”) the cost of the operating departments can never follow the rise and fall of the average paying load. This, however, is rather a question of cost and not of product. The gross ton-mile is a convenient divisor for departmental expenditure, as will be seen in another place. As however it is generally prepared with the other mileage statistics some reference will be made here to methods of compilation.

The first method is that used in India, and is based partly on a computed classification of rolling stock weights. It is prepared in the audit office. A list of the stock in service is used, in the same form as that accompanying the yearly reports, except that the vehicles are classified in groups according to average tare, including a separate group of special or “miscellaneous” vehicles, the number of each description of which does not exceed 2 per cent. of the whole. Brake vans are kept separate and passenger vehicles in classes. Against each type of vehicle in the list is placed the average tare, and this, multiplied by the mileage of that type of vehicle, gives the ton-miles of dead weight. It will be seen that it is necessary, to give effect to this, that the vehicle-mileage register should be kept in the same detail as the classification of stock. The work of recording vehicle-miles is thus considerably augmented, unless, as in the case of certain



Telegraph Code calls are used for names of stations, and the end column is left blank for head office use, to be filled in with the multiplications which give the sum of gross ton-miles for the train. It will be seen that the greater part of the work is done by the guard, who totals the number of wagons and tons on his train on leaving each station, which is also the number of tons hauled to the next station. These tons, multiplied by the length of the section, *i.e.*, the distance between the two stations, give the total gross ton-miles hauled.

This is simplicity itself. A complete record of the working of the train is contained in the one sheet and materials are available for the compilation of all the statistics required, train-miles, vehicle-miles (loaded and empty) and gross-ton-miles, all ready for summarising at headquarters. The gross-totals of all these units can thus be complete within say 10 days of the end of the month, if the abstracting of the journals be effected daily. The extraction of ton-mileage from these guards' journals would also be quite feasible, at the sacrifice of some degree of exactitude, but there would be no means of distinguishing commodity-ton-miles and light traffic would have to be estimated.

*Vehicle-miles.*—In the preceding description of the method of compiling gross-ton-mileage, a model is given of a guard's journal showing a simple and accurate record of vehicle-mileage. The summarising of this should be done in the traffic superintendent's office, and the extent of this work will, of course, depend largely on the amount of detail required, *i.e.*, whether it be desired to record mileage for each class of stock or for each section of the line. If the simple total of all mileage be all that is necessary (as in the case of a small railway) the labour involved in registering the total of each journal will not be great, where, as herein described, the major portion of the work is done by the trainmen. In this simple form 30 or 40 journals could be added and registered in an hour. Probably in less, if the total were added to the gross total brought forward from the previous day, on the journal itself.

It is hardly needful to define the wagon-mile. It is, of course, the expression of a wagon run one mile. It is a variable unit inasmuch as it takes no account of class of vehicle and weight. A wagon-mile may be a mile run by a low-sided truck of 10 tons weight, or it may represent a modern mineral wagon of 50 tons gross. Otherwise this unit is regarded as a very reliable measure of work performed on many systems, where the executive officers



prefer it to the ton-mile. It has moreover the advantage of greater facility of compilation, as those wagon-miles only are recorded which are run by the owning company's engines, and, therefore, which are in the charge of that company's staff.

The principal end of vehicle-mile statistics is to enable a watch to be maintained over the effective user of rolling stock. For this purpose the record must be kept in two parts—loaded and empty wagon-miles. An absolutely perfect, but of course unattainable, state of things would be to have no empty mileage, to load every wagon with the certainty that it would meet a load for the return journey. In these unattainable conditions the return would stand: "loaded mileage, 100 per cent.; empty mileage, nil." Failing this Utopian result, the aim will be to secure as large a percentage as possible of productive user, that is, of loaded mileage, or rather, to keep the unproductive or empty mileage as low as possible. Cases are not unknown, on the most efficiently managed road, of empty trucks from station A to station B on one train crossing empties of the same type on another train bound from B to A, and also of wagons being asked for and returned unused. All such cases should be reported and corrected, and perhaps are, but the true criterion of the efficacy of the work of the outdoor staff is the wagon-mile figure.

If the mileage be compiled from the guards' journals, it is a comparatively easy matter to divide the record into (I) sections of main line, and (II) branch lines, especially as separate journals are often started at given points dividing a long journey into sections.

Any increase of unproductive running can then be located and immediately investigated. Subject to the conditions obtaining on different sections or branches, such as a marked difference in the class of traffic hauled, the comparison of the empty running figures as between the several districts will be a profitable one.

*Traction ton-mile.*—The percentage of empty wagon-mileage indicates the amount of non-productive running of wagon stock, but is not a complete measure of efficiency, in two respects; first, as already noted, it affords no check on light loading, and takes no account of the work of the wagons in weight hauled. Secondly, it furnishes no indication of the efficiency of the train. For this purpose there is what is perhaps one of the best units ever invented for the direct measure of efficiency in operation, the



“traction ton-mile.” This figure may best be described as a check on the productive work accomplished by the locomotives. The perfect state again would be for the locomotives always to haul trains carrying a load corresponding to the maximum capacity of the particular type of engine used, which would, of course, constitute 100 per cent. effective traction load. The traction ton-mile is the measure of the effective power supplied, and is therefore the debit against traffic department. The total debit is the whole of the force supplied by locomotive department, and as this includes light running, trials, and engine failures, all these items stand as credits to traffic department. Now by measuring the effective power supplied, *i.e.*, the traction ton-miles, against the work done, which is the gross-ton-miles actually hauled, a figure is produced which represents the degree of efficiency obtained.

There is no particular difficulty in the compilation of traction ton-miles, especially where gross-ton-miles are recorded, and it offers this advantage, that its use can be limited to one or several sections, or it can be taken out for the whole of the service. Something of this sort is done on the Great Western and Great Central, where the train loads are compared with haulage capacity of locomotives on certain ruling sections.\* The method now suggested is to use the table of haulage capacities of locomotives as a basis. The gross-ton-miles recorded on the guards' journals are separately added for each section, as shown on the model journal reproduced on page 26, and are entered into a register which may be in the following form, one or more sections on each page, or which may be added to the register of gross-ton-mileage :—

Date.	No. of Train.	Class of Locomotive.	Section A—B.			Section B—C.		
			Capacity in T.T.M.	G.T.M.	Per Cent.	Capacity in T.T.M.	G.T.M.	Per Cent.

\* Railway Accounts Committee, Minutes of Evidence, QQ. 4374 and 7405.

The whole working of the train can thus be carried through the various sections along its route, and then added across, if it be required to show the working of each train, whilst the totals of the columns give the percentage of the available power utilised on each section, and any falling-off is immediately located. The traction-ton-miles for the class of engine working the train are made up from the locomotive haulage capacity table. For example, a Class A locomotive is booked to haul a maximum load of 300 tons over the ruling gradients of section A to B, and the mileage between these two stations is 20, then the traction-ton-miles ("T.T.M."), *i.e.*, what that locomotive is able to haul, are represented by  $300 \times 20 = 6,000$ . Now suppose that some of the wagons on the train run empty and others run with light loads, and further, that the train is one or two trucks short of its registered load, the gross-ton-miles may only amount to 4,000, or 66 per cent. Clearly the result is that one third of the available power has not been utilised. The indication conveyed by this result in actual practice would be, (*a*) that a smaller type of locomotive should have been booked to run the train, or (*b*) that the train (if conditional) should have been cancelled, or merged with a later service.

On the other hand it is possible to obtain 100 per cent. or over, on the working of some particular section or train, such for example as a constant mineral service. When the maximum is repeatedly exceeded, the indication is either the reverse of the antecedent example or else points to the necessity for a revision of the maximum loading scale of locomotives.

It will be admitted that the traction-ton-mile is an excellent means of measuring efficiency of operation, inasmuch as it is a composite and convenient figure recording weight, distance, and the power utilised, and thus combining measures of product and cost. It must be remembered, however, that gross-ton-miles include dead weight (and possibly non-productive dead weight) of stock, and that therefore the wagon-mile figures cannot be dispensed with. It is possible, on railways with heavy gradients and a one-way traffic, for a large proportion of the running "against the grade" to consist of empty vehicles. Such conditions are often found on railways running from the coast to inland mining districts, where the traffic is almost wholly in full train loads down-grade, and where the capacity of the locomotives is limited to the number of empties they can haul up-grade. In such a case the ratio of traction-ton-mileage would be roughly

100 per cent., but at the same time there would be 50 per cent. of empty wagon-mileage run. This of course is an exaggerated case, but the Taltal Railway (to whose traffic superintendent, Mr. J. S. Burns, the author is indebted for some interesting data on the subject), obtain in actual practice the remarkable figure of 92 per cent. of their possible traction-ton-miles.

The suggestion is made above that the two records, the gross-ton-miles and the traction-ton-miles, could be taken out together, and kept in the same register, and there is another consideration which may be noted in this connection. On many railways the locomotive department prepares the "average weight of train hauled" in which considerable clerical work is involved. If gross-ton-miles or traction-ton-miles were compiled, this clerical work would be unnecessary, as the figure of average weight of train could be furnished periodically by Traffic Office from the register kept. It would be obtained by simply dividing the gross-ton-miles by the train-miles, and thus eliminating the factor of distance, the remainder being gross-tons per train. Some extra work in one department would therefore be compensated by a reduction in another.

*Capacity-Miles.*—The traction-ton-mile is the measure of the capacity of the locomotives, and the "capacity-mile" is the measure of the capacity of the rolling stock. The mileage of carrying capacity is the total vehicle-mileage run multiplied by the average carrying capacity. In the case of carriages the carrying capacity is expressed as "seats," and in that of wagons as "tons." The average capacity is obtained from the working time book, from the half-yearly certificate of rolling stock, or directly from the carriage and wagon department books. The average seating capacity of each class of carriage and the average maximum load of each type of wagon should in any case be obtained. Then these are multiplied by the vehicle-mileage to give the total carrying capacity hauled, and this total is compared with the passenger and ton-miles, the difference being the unproductive capacity hauled—in other words, the capacity hauled and not utilised. The final figure is generally expressed as "percentage of paying freight on capacity hauled." An example will make this quite clear. A carriage with seating capacity for 50 passengers runs 20 miles; the capacity-miles are  $50 \times 20 = 1,000$ . But the 50 seats have only been occupied by 25 passengers travelling distances which average 10 miles per passenger, or 250 passenger-miles; therefore the ratio of paying

load to capacity hauled is 25 per cent. Similarly in the case of freight traffic, 10 wagons of 10 tons average capacity hauled 50 miles are equal to  $10 \times 10 \times 50 = 5,000$  capacity-miles, and if the train has only hauled 2,500 ton-miles of paying freight the ratio is 50 per cent.

The percentage varies very much in different countries, due to the nature of the traffic carried. A line with a heavy pilgrim traffic will have a high percentage of carriage space utilised, and on the freight side the percentage will always be high where it is possible to obtain a large proportion of return loading.

On an old established railway the percentage of paying load should fluctuate very little in similar periods from year to year and any noticeable fall requires investigation. If the statistics are detailed in classes of vehicles and sections of line, the abnormality can be located immediately. It may be attributable to any one of several causes. Accommodation may have been increased on a certain train in a previous month and not readjusted after the rush of traffic had ceased. The actual amount of traffic passing may have decreased without any corresponding reduction of service. The true reason for the fluctuation will often be revealed at once by a reference to other statistics of the same period.

*Average Load.*—This unit serves almost identically the same purpose as the "capacity-mile." Both are not really required, and a choice of one or the other will be determined by the conditions of operation. The average load is the more commonly used for the simple reason that, having ton-mileage available, it is the more readily and cheaply obtainable. The term "average load" covers four distinct units:—

1. Average number of passengers per train.
2. " " " " " coach.
3. " " " " " tons per train.
4. " " " " " truck.

All these figures are obtained by the elimination of the factor of distance from the train-mile and ton-mile units, and all that is required in each case is a simple division sum. No. 1 is the passenger-mileage divided by the passenger-train-mileage; No. 2 is the passenger-mileage divided by the passenger-vehicle-miles. Similarly, No. 3 is the ton-mileage divided by the goods-train-mileage, and No. 4 is the ton-mileage divided by the goods-vehicle-mileage. A fifth unit may be described under this head, the average weight of train hauled, generally used by the locomotive department as a measure of the work performed by the



locomotives. This is obtained by dividing the gross-ton-mileage by the total train-miles, and as already stated, can be so easily extracted in this manner that the same unit compiled in the locomotive department may be dispensed with.

The average train load, by which is meant more particularly the average number of tons of paying freight carried by goods trains, is one of the most important of all the statistical units. It can only be arrived at by means of the ton-mile figure, and is one of the figures that render the compilation of ton-mile statistics almost indispensable. Without the average load the only information available regarding the profitable working of trains is derived from casual personal observation, which, however conscientious, does not discover a gradual and insidious loss of efficiency. These observations apply with equal force to the average wagon load, which is also dependent upon ton-mileage statistics. Both units are required for the same purpose, to ensure a profitable use of rolling stock.

The advantage of securing full loads wherever possible is sufficiently obvious in itself. A certain proportion of dead weight has to be hauled in any case, and the greater the paying freight that is hauled with it, the greater the proportion of profit. The dead weight is non-productive, the paying load is productive, and in the ratio between the two lies the difference between profit and loss. A wagon of five tons tare running about with a load of 1 ton is not earning its living. This patent fact has led to the introduction in all countries of high-capacity wagons, in which the ratio of tare to paying load is reduced to the lowest possible figure compatible with safety. Tare weights may vary from 5 tons to 30 tons, but generally speaking (and without taking into account special stock, such as boiler wagons, &c.) the specialised vehicles are those with the most productive ratio of capacity. Some modern American steel mineral wagons, for example, are designed to carry as much as 50 tons load to a tare of 15 tons, a ratio of 77 per cent. of paying load to gross weight hauled.\* Where, as in the United States, coal, coke, and ores of the commoner minerals are carried at extremely low rates, the margin of profit is so exceedingly small that only by the attainment of a high degree of perfection in design of locomotive and wagon stock, and in operating methods, is it possible to run traffic at a profit. With rates of under  $\frac{1}{4}$ d. per ton per mile, such as

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\* Bulletin of the International Railway Congress, May, 1910.



obtain in the United States for mineral ore and coal, a high average load is an absolute necessity.

While it is true that without the ton-mile figure it is impossible to obtain the average train or wagon-load for the whole of the traffic, this does not necessarily apply to mineral traffic carried in complete trains, since in this case the average load is the starting load, and a return of the wagon weights at the forwarding station will furnish the information required to obtain good loading. Even in this the "average" cannot well be dispensed with as the value of the starting load figure is partly lost if it be presented in such a form as to render necessary the scrutiny of long rows of cyphers. The loading from each station therefore, or from each siding, and for each train, should be averaged, the sum of the wagon-loads being divided by the number of wagons, and the result submitted daily or weekly. This method is the one largely used in England, and can be followed without recourse to ton-mile statistics. At the same time, mineral traffic is comparatively easily ton-miled, and it would be a great advantage to have both a daily figure, based on starting loads, recorded and used in the District Superintendent's office, and a monthly figure, compiled from the ton-mileage, presented at headquarters. Moreover, the starting load figure will not furnish a true average train-load, since it has the defect of ignoring the distance factor. It is not enough to know that the trains are starting with a good load. The object of the train-load unit is to betray unproductive light running. A train may start with a full load of trucks, and perform the latter portion of its run day after day with a light load. The remedy for this would lie in a rearrangement of engine power, but the light running might go on for a long time unperceived if the starting load only were relied on.

Another method of checking train-load is by the number of trucks, *i.e.*, average number of wagons per train, arrived at by dividing wagon-mileage by train-mileage, and therefore again independent of the ton-mile. Obviously one defect of this unit is its disregard of the weight factor, and it may also be seriously affected by engine capacity and speed variations in the running of the trains. The defect of these variations is very clearly explained by Mr. W. Marshall, of the North-Eastern Railway, in the following paragraph of his paper on "Traffic Statistics and Freight Train Working."\*

"Wagon-miles per train-mile indicate freight train-load, but

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\* *Railway Gazette*, March 23, 1906.

when these figures are aggregated the resulting figure (as a disciplinary agent) needs treating with the utmost caution. As previously explained, the train-mile ignores speed, but speed is in direct relation to load, it being, of course, a universal rule that the higher the speed the lighter the load, and it may thus happen that an increased or decreasing freight train-load, as shown by the wagon-miles per train-mile, may be wholly or partly due to speed variations.

“To take a simple illustration. Suppose there are 10 trains, A to B, and the maximum load at Class C is 50 wagons each. This, assuming each train gets a maximum load, and the distance A to B is 50 miles, gives an aggregate wagon-mileage of 25,000 miles; an aggregate train-mileage of 500 miles, and of course an average wagon-mile per train-mile of 50. Circumstances render it necessary to accelerate two of the trains to catch a connection or market; they are lifted from Class C to A with a maximum load of 33 wagons. Assuming every train to get its maximum load, the resulting figure shows a shrinkage from 50 to 46.6. Again, it is perfectly possible to increase average train-loads per train-mile by the adoption of more expensive methods of working. Take the last illustration of 10 old tender engines, which averaged 50 wagon-miles per train-mile, and suppose they be reduced to six old tender and three Class T. There would be one engine saved and 50 miles less train-mileage, but the wagon-mileage would be the same, and therefore the resulting average would be 55.5, an increase of 5.5; but if the increased capacity had been taken into account the T's should have lifted 294 instead of 200 wagons, and therefore to obtain as good a result as the old one, the resulting average should have been 66 instead of 55.5.”

The lesson to be derived from the foregoing is that the figure of wagon-miles per train-mile is inferior for general supervision to the “traction-ton-mile,” since the latter covers—in addition to the train-load—the capacity of the engine used.

Perhaps this particular form of the average load figure (*i.e.*, the “vehicles per train”) is more usefully applied to passenger traffic than to freight. For example, a rush of excursion business may require the strengthening of certain trains, which may not be reduced afterwards to the original strength. This would be revealed by a fall in the number of passenger-miles per train-mile, but the vehicles per train, worked up on the “starting-load” basis, would also have its value in the hands of the District Superintendent, if rendered daily.

The number of passengers per coach and per train is shown in the reports of a great many railways abroad. It is an interesting figure, and, where passenger-mileage is available, is quite easily computed, as explained above, by the division of passenger-miles and vehicles and train-miles. As a unit it is closely related to coaching "capacity-miles." From a purely operating point of view, the number of passengers cannot be increased at will, and attention must be directed to limiting the seating accommodation to the lowest point compatible with the service demanded. In other words, the number of passengers per coach is increased by reducing the seating capacity per passenger. Therefore the necessary control is better obtained by means of the units previously referred to, "carriages per train" and "capacity-miles," and the number of passengers per carriage and per train is only useful for comparison of similar periods, and with other railways and also, of course, as a permanent single-figure check on the other statistics.

*Average Lead.*—The average lead is the average distance the traffic has been carried. In the case of passengers, it is the average length of journey travelled by all passengers, and in treating of freight it is the average "haul," or distance each ton has been hauled. It is arrived at by dividing the passenger-mileage by the number of passengers, and the ton-mileage by the number of tons. The average lead is considered to be one of the most important of those units directly obtainable from ton-mile statistics, and obtainable in no other way, and for this reason, that the distance traffic is carried has a very serious bearing on the question of cost. It costs considerably less to carry 1 ton 100 miles than it does to carry 10 tons 10 miles, although the amount of work done, 100 ton-miles, appears to be the same. The difference lies in the terminals, *i.e.*, the charges borne by the railway at both ends of the journey for services other than actual transport. The consignment of 1 ton (supposing it to consist of "Carted and Delivered" traffic) has to be collected and loaded at the forwarding end, and unloaded and delivered on arrival, and these services, as well as invoicing, checking, and the accounting and supervisory work, are the same, whether the goods are carried 10 miles or 100 miles. In the same way locomotive costs do not increase in equal ratio to miles run; shed charges, cleaning and lighting up cost as much for one engine to run 10 miles as for another to run 100. In both cases the terminal expenses are spread over a

smaller or greater length of haul, and the cost per mile is, therefore, progressively less as the distance increases. These facts contribute to the importance of the "average lead" statistics.

The value of this unit in connection with the compilation or revision of rates has been disputed, and it is true that the average figure for the whole of a mixed traffic would not be of much assistance in the fixing of a rate for a given class. On the other hand, the average haul for a certain commodity, such as coal or bricks, where large tonnage is carried in full train loads, must be of prime importance.

The total figure has other uses. It will often furnish the explanation of fluctuations in other units. Decreased receipts per passenger or per ton of freight may be due to a reduced length of lead as well as to a preponderance of lower rated traffic, and one cause of such a decrease is therefore to be looked for in average lead. Receipt and cost per train-mile are also both affected by average lead.

*Average Rate.*—Average rate (or average "receipt") is the average rate of fare received per passenger per mile, and the average rate of freight collected per ton of goods per mile. It is obtained by dividing the passenger receipts by the passenger-miles, and the freight receipts by the ton-miles. Where ton-mileage is compiled in classes and commodities, receipts will be subdivided to suit, and the average rate may be ascertained for any branch of traffic. This unit and the preceding one go hand in hand. A decrease in average rate probably corresponds to a reduced average haul, and *vice versa*, although this may also be brought about by an increase in traffic at reduced fares or lower rates which has the effect of lowering the general average. A reference to the tonnage of different classes of traffic would reveal this, if the average by commodities did not furnish the explanation.

Equally with the average lead this unit may be used in the construction of rates and fares, and for this reason alone it is one of the most important of the statistics arising out of ton-mileage.

*Density of Traffic.*—Density of traffic may be expressed in several ways. Some would say that density of traffic is simply the number of trains running over the line (train-mileage divided by route-mileage), whether the trains be slow or fast, or long or short. It may also be expressed by the number of wagons working (wagon-miles divided by route-miles). These figures, however, would only indicate "density of train movement" or "density of



wagon movement" respectively, and the correct basis for "traffic density" is the ton-mile, the ton-mileage divided by the route-miles, in the case of freight, and passenger-miles divided by route-miles for passenger traffic. This method alone produces the figure required to give a true indication of the amount of traffic passing over the road. No other unit is suitable for the comparison of the extent of the traffic of one line with that of another. At the same time it is not, strictly speaking, an operating figure, and is introduced here as one of the compound units of the ton-mile series.

*Engine Hours.*—In the preceding pages the statistical units dealt with have been those related more or less directly to the mileage of trains, tons, and passengers, *i.e.*, to the units of product, the measures of work done in exchange for certain payments from the public. Now the true criterion of efficiency is not only the quantity of work done with a given equipment, but the proportionate cost of the operation, and this introduces a very large question. The cost of the whole of the work performed is obviously the total of the expenditure, the actual disbursements of the company as shown in the Revenue Account, but this is of little use as a basis for the preparation of a unit suitable for the measure of cost from day to day. It is not immediately available, and covers many charges which are not directly related to the movement of the traffic. Even when the consideration of cost has been narrowed down to expenditure in the operating department alone, this still contains charges which are not affected by variations in traffic. Following the process of elimination it will be found that the only costs which directly correspond to the running of trains, and therefore to the productive work of the equipment, are those of fuel consumption, lubrication, and the wages of the trainmen. These costs are "active" during the whole of the time a locomotive is in service, and this brings the argument down to the unit required, the "engine-hour." The engine-hour by itself is however a measure of time only. It may rise or fall, as an aggregate, but such rise or fall will convey nothing until it appears side by side with the figure representing the work done, or in other words, until it is compared with the unit of product. The running of trains and wagons forms the unit of product, and the engine-hour the measure of cost. A combination of the two will show the amount of productive service performed in exchange for a given expenditure, or, more correctly phrased, the expenditure incurred in performing a given amount of work.



The engine-hour, in effect, forms the debit to the operating department, and the test of efficiency is the amount of credit, in the shape of productive transport, the operating officers are able to show on the other side of the sheet. The figures are generally collected in a register from the driver's tickets, at the same time as the mileage, and the engine-hours should be considered as "shed to shed" time, *i.e.*, the time the engine is at the disposal of traffic department.

The defect of the engine-hour is that it ignores the capacity of the locomotive, and perhaps in time to come this factor will be taken into account, by increasing the value of the engine-hour in ratio to the weight or drawbar pull of each class of engine. A step in this direction has already been taken on some railways where locomotives of the Mallet or Kitson-Meyer type are used, each mile run by these classes being calculated as equal to two ordinary engine miles, for the control of coal and oil consumption. It is found that such high capacity machines use much more fuel, and the cost per mile run, and therefore per engine hour, is correspondingly higher. Coal being the principal item of cost, a scale of engine-hour values for different types of locomotives might be calculated on the basis of the average coal consumption. For example, if Class A consume 50 lb. of coal per mile and Class B 60 lb., the engine-hours of the latter would be increased by 20 per cent. before being included in the total hours for use with other units. Then, to be consistent, the capital value of the different types should also be taken into account, and a further addition should be made in the case of an engine on overtime, but these are refinements. This question is also dealt with in the chapter on "Locomotive Department Statistics."

The engine-hour unit may be recommended to the student as being especially important in England, as it is in itself quite independent of the much-discussed ton-mile statistics. The compound unit of ton-miles per engine-hour is undoubtedly the best use that can be made of the figure, but there are other combinations of great value, such as—

Train-miles per engine-hour, and  
Wagon-miles per engine-hour.

Both these figures are self explanatory. The first is more particularly appropriate to the periodical survey of passenger train working. There is little variation in the average speed of passenger trains from month to month, and the figure therefore

provides a valuable check on the amount of unproductive time spent by engines in terminal stations, assisting and shunting. The total of the productive hours is the train running time, which is ascertainable once and for all from the time-table, and another method of checking wasted time is to compare engine-hours with train-hours. The difference between the two is made up of light and assisting engine work, delays, and breakdowns. The smaller this difference, therefore, the greater the degree of efficiency.

In dealing with freight trains the combination of wagon-miles per engine-hour is the best measure, but it must be remembered that both the units are unstable in themselves, and that, therefore, the combination of the two can only be used with knowledge and care. Unless reduced to equivalent-hours as suggested above, the engine-hours are based on the timings of several different types of locomotives, and in the same way the wagon-miles fail to distinguish between heavy and light, and often, between loaded and empty. Nevertheless the unit is a valuable one, and while it is necessary to call attention to the defects of such average figures, it is not to be supposed that any sensible person is going to rush blindly to conclusions on the indications of a single statistical unit, without any investigation into the variations it shows.

Some of the variations in the wagon-miles per train-hour are beyond the power of the operating staff to remedy. For example the addition of a section of new line will form an increase in length of lead, and will run up wagon-mileage out of proportion to running time. Or the addition of a shunting loop may so facilitate marshalling work as to economise engine time, and again increase W.M. per E.H. The same effect is produced by the introduction of more powerful engines, and, conversely, the use of a larger type of truck will pull down the result. As far as the locomotives are concerned it is preferable to summarise the hours made by classes, as even if no addition be made to value of hours on account of higher capacity, as it has been suggested might be done, the fact of one of the heavier classes showing a higher aggregate of hours in proportion to the total this month than last, is sufficient to explain a certain degree of increase in the W.M. per E.H. Speed of trains is another factor which may affect the total, although, if the majority of trains be booked trains, the running time has not the same influence over the result as the time due to shunting, assisting, delays and breakdowns.

*Ton-miles per engine-hour.*—As remarked above this figure is probably the best of all the compound units, the most comprehensive measure of efficiency in the work of conducting transportation, that can be compiled. The ton-miles show exactly the work that has been done, and the engine-hours, within the limitations mentioned in the preceding paragraphs, afford the most concrete index to the cost of doing it. The final figure may be obtained directly by the division of the engine-hours into the ton-mileage, or it may be obtained through the combination of the nearly related units, train-miles per engine-hour, wagon-miles per train-mile, and ton-miles per wagon-mile. It should be noted that as the final figure combines the values of the component parts, any reduction in train-load, or in wagon-load, or in punctuality, will betray itself in the variations indicated by the final figure, as well as any increase of engine time due to excessive shunting or light running. Obviously therefore the compilation of the unit through its three component units will assist in locating the variations to one of the three.

*Gross-ton-miles per engine-hour.*—This is a very similar unit to the last, except that it takes into account the whole of the work done by the engines. It is unnecessary where "traction-ton-miles" are used. The G.T.M. has this advantage over the ton-mile, that it can be compiled more easily (through the medium of the guards' journals) than can the ton-mile itself, and is available at a much earlier date. On the other hand the unit of G.T.M. per E.H. gives no indication of paying load of wagons or trains, as does the preceding unit. It is, however, the true statement of weight of train hauled, and has been dealt with in this connection in the chapter on Locomotive Department Statistics.

*The Use of Traffic Statistics.*—The description of the units described as Traffic Statistics in the foregoing pages has made it quite clear that there is a certain degree of instability in each unit, and that a combination of these units is apt to increase such instability. The average is the result of all the components of the average and it is an axiom that the validity of the conclusion cannot exceed that of the premises. The greatest care therefore should be exercised in dealing with statistics, and the student is again referred to the excellent paper by Professor Dewsnup (reprinted by the *Railway Gazette* in pamphlet form) on "The Necessity of Care in the Interpretation of Railway Statistics used Comparatively."

Another point which it is necessary to mention is that although

in the present work a very large number of statistical units are described, many of these are really alternative, and it is not intended to suggest that the whole of the figures should be compiled and used at one and the same time. On the contrary, the virtue of a statistical unit lies in its power of expressing a great amount of detail in a single figure. If the statistics are unduly multiplied this advantage is lost. On the other hand, certain of the units show a mutual affinity which is of undoubted assistance in tracing variations. The choice of a unit will depend on the conditions which it is intended to measure, and which vary on every railway. Care should be observed also that the compilation of statistics is not continued longer than their usefulness requires.

The fluctuations shown by Traffic Statistics are of varying importance, and the point at which the increase or decrease begins to show a loss of efficiency is a matter of experience. Immediately the rise or fall of the unit exceeds the normal periodical variation, investigation should be put in hand. The statistics should be dissected down to the point where the loss can be traced and this should preferably be done outside in the stations or yard-master's offices, so that the staff at those points may not only be made aware of the object of the returns they have to prepare, but also that they may be induced to take an intelligent interest in the improvement of results called for by headquarters. This, and the necessity for a complete disintegration of the statistical unit for purposes of investigation, are powerful arguments in favour of the compilation of traffic statistics in a subdivided form, train by train, and district by district. Decentralised in this way they are earlier available for use by the outside staff, and at the same time there is a ready-made comparison produced at headquarters.

By training the staff in the use of statistics an intelligent interest is aroused, and the figures will have already largely served their purpose if they have drawn the attention of the operating officers to the results of their own work.

## CHAPTER III.

### DEPARTMENTAL STATISTICS.

#### WAY AND WORKS DEPARTMENT.

Of the three working departments, that responsible for the line itself, the track, buildings and fixed plant, is the least amenable to a thorough control by statistical units.

*Expenditure per mile.*—The first and universally used index figure is the cost per mile of line. The expenditure subdivided under its different heads, is divided by the number of "route-miles" (miles of line open to traffic) and the result forms a reliable average figure for comparing the working of the department during two or more similar periods. This might be shown in a book of the form recommended for the Locomotive Department in the next chapter. As the miles of line open include single and double line, and take no account of sidings, loops, &c., the subdivision should also be made on the basis of cost per "track-mile." The total of the track-miles includes all main lines, branch lines, loops, sidings, and is in fact half the exact length of the rails laid in the track.

As all these rails have perforce to be maintained, whether they are in main lines or in sidings, the track-mile is a much more comprehensive figure than the route-mile. Certainly the upkeep of main lines is much more expensive than that of sidings, but it would be very difficult indeed to divide the cost between the two classes of work ; hence the two sub-divisions.

On a railway of any length it is almost indispensable that the Chief Engineer should have at his command a measure of the cost of each of his sections and branch lines, divided in the same way by the respective track-miles maintained. To this end all vouchers, contractor's certificates, pay-lists, and stores debits are labelled with the number or letter of the section to which they refer, and the subsequent classification in separate columns requires comparatively little extra work. There are difficulties of allocation but a very fair division can be arrived at of all the common charges. Superintendence should preferably be



subdivided between the different sections in proportion to the total cost, and not on a basis of length of line.

*Telegraph maintenance "per pole."* *Signals "per arm."*—In addition to the expression of the costs "per track-mile," telegraph maintenance should be shown "per pole," or "per mile of wire" and maintenance of signals "per arm." The nature and use of both these figures is self evident.

*Men per mile.*—Another unit which may be of considerable assistance in controlling expenditure is the "men per mile." The nature of this unit is also obvious. It is simply the total number of men in the maintenance gangs, with their gangers, and others directly engaged on the upkeep of the road, divided by the miles of track maintained. In some respects this unit forms a more valuable control than a comparison of the expenditure, as it is less variable, and is not affected by the anomaly that may result from an extraordinary item of expenditure on bridges, for example, being divided by track-miles, which have nothing to do with the bridge. This is one of the defects of the average figure which cannot well be avoided. The "men per mile" is not subject to the same variability, and may be used to compare different sections in different periods, with some confidence. It is customary in making the total for this unit to count only the men actually engaged on the track, *i.e.*, gangers, platelayers and labourers, and it can be rendered still more exact by taking from the pay-list not simply the number of men employed but the time they have worked, that is, the total number of hours, or days, paid for in wages. This total time, (divided if in hours by the standard working hours per day) will give the number of "men days," which, divided by the number of working days in the period, furnishes the average number of men. In this way the result is not vitiated by duplication, since "men days" only count two men working half a day, for example, as one "man day," whereas simple counting would give two men. It will be seen that the distinction is an important one, especially so when a large number of extra labourers have been engaged perhaps a day or two on a breakdown or relaying job.

There are other units available, with very little extra clerical work, in the Way and Works Department, such as cost of bridge painting "per ton" of ironwork, and ballasting expenses "per cubic yard" of ballast. These are, however, often suitable only for certain railways where special conditions require special measures of efficiency. Whatever unit be adopted it is most important

## WAY AND WORKS EXPENDITURE.

Section X to Z, .....miles..... chains.

	Average per month last year.	Amount.		Per open mile.		Per track-mile.	
		19...	19...	19...	19...	19...	19...
A. <i>Superintendence—</i>							
1. Salaries ... ..							
2. Office expenses ... ..							
B. <i>Maintenance of roads, bridges and Works—</i>							
3. Earthworks ... ..							
4. Bridges, tunnels, culverts, retaining walls &c.							
5. Roads and fences ... ..							
C. <i>Maintenance of Permanent Way—</i>							
a. Renewals of running lines :							
6. Wages ... ..							
7. Materials ... ..							
8. Engine power and wagon repairs							
b. Repair of running lines and sidings :							
9. Wages ... ..							
10. Materials ... ..							
11. Engine power and wagon repairs							
D.—12. <i>Maintenance of signals</i> ...							
E.—13. <i>Maintenance of Telegraph</i> ...							
F.—14. <i>Maintenance of stations and buildings—</i>							
15. Stations, depôts and offices ...							
16. Engine sheds ... ..							
17. Carriage sheds ... ..							
18. Locomotive workshops ...							
19. Carriage workshops ... ..							
20. Wagon workshops ... ..							
21. Other buildings ... ..							
Totals ... ..							

that the accounting staff of the department have full instructions as to allocation, and that uniformity be observed in the classification of expenditure, as otherwise the value of comparison is nullified.

#### LOCOMOTIVE DEPARTMENT.

The conditions of work in the Locomotive Department, (and under this head will be included the maintenance of all rolling stock), allow of a very extensive use of average statistics. It is impossible for the superintendent to watch in detail the working of every engine, carriage and wagon, and he must therefore have at his command such statistical units as will convey in one single expression a measure of the work done in the department under his charge and the cost of doing it.

#### LOCOMOTIVES, RUNNING AND REPAIRS.

*Engine-miles.*—Engine-miles are the measure of the distance run by the engines, and are generally understood to cover the work done by the locomotives between leaving and returning to the shed or depôt. In England the total mileage run is summarised by the driver in a weekly return, together with the train-miles, and sometimes the wagon-miles. The return shows :—

Train-miles	Piloting (hours)
Engine-miles	Shunting (hours)
	Ballasting.

The equivalent of piloting hours is arrived at by calculating each hour as two miles, and "piloting" is generally understood to cover the time a reserve is waiting to relieve another engine. Shunting is entered at the equivalent rate of four miles per hour, and ballasting at eight miles per hour, (unless the actual mileage is ascertainable and exceeds this rate). In India, both piloting and shunting hours are converted into mileage at the rate of five miles per hour.

Engine-miles are principally used by the Locomotive Department for the control of coal and oil consumption, the determination of mileage and coal premiums, and as a measure of the work done by each locomotive in relation to running expenses, cost of repairs and life of material. For this purpose it is usual to have a sort of ledger, for each type of locomotive, with provision for a day or a week on each line, according as the records are made up, from the driver's tickets daily, or from a weekly return. The book is ruled with a column for each class of train, and each column provides space for (i) engine-mileage and (ii) engine-hours.

A column is left for coal and oil, to be entered from the coal delivery book each week or month, and a simple combination of the totals gives the consumption of coal and oil per engine-mile, for each engine.

From the summary of this book the following periodical return is furnished to the officer responsible for the section or department.

Section..... Class of locomotive..... Period.....

Loco. No.	Days worked.	Miles run.	Hours service.	Coal, lb. per 100 miles.	Oil, lb. per 100 miles.	Shed repairs.	Times washed.
Totals and means.							

The performances of every engine are thus recorded in a condensed form and the totals form a true measure of the work done by the department.

*Engine-hours.*—This is perhaps a more reliable measure of expenditure than the engine-mile. It is generally made to include the time “from shed to shed,” or in other words, the time during which a locomotive is at the disposal of traffic (or way and works) department. Whether it be standing still or working it is always consuming fuel and the wages bill is running on, and for this reason, the “engine-hour” unit is more comprehensive than the “engine-mile.” Both “engine-hours” and “engine-miles” should be classified between passenger, goods, and mineral trains, or otherwise important variations may be lost sight of; an increase in one service may be covered by a decrease in another. A defect of both the units is that the total figures cover the performances of different classes of engines, the initial cost of which individually may vary as much as 2 to 1, and the engine-miles or engine-hours do not vary although one engine may be

merely standing or shunting and another be running an express goods with a high consumption of coal and highly paid crew. At the same time the average total figures, when used with a knowledge of the circumstances, are none the less indispensable, and specially for the use in the department itself where those variations being constant from year to year, the comparison is not seriously affected. Moreover, it is the light running and standing under steam that it should be the aim and object of the management to minimise, and any excess of unprofitable working will show in the average figures when compared as between two different sections or two different periods.

Probably, when a greater degree of perfection has been reached in the use of statistics, engine-miles and hours will be graduated to allow for the difference in capacity of the various types in use. Some distinction is obviously required between a Mallet engine running heavy mineral trains, and a six-coupled tank working a light passenger service. The inventive capabilities of the student have in this problem an interesting field for operation. It really resolves itself into a question of giving the engine-hours of different types of locomotive their true value, and whether any addition or subtraction (from the bare figure of time) should be on arbitrary lines or whether it should be based on some highly theoretical formula, embracing, say, the draw-bar pull, the average speed, and the coal consumption, added to the unit or subtracted.\* Or the weight alone might be used, seeing that the heaviest engines generally do the heaviest work and consume most fuel. This again would not be invariably true of some modern passenger locomotives. In any case it is preferable to keep separate records of mileage and hours for passenger and freight service. At least one railway (an English-owned line in Chile) has already done something on the above lines, as (I) engine-miles run by their locomotives down grade on their heavy coast section only count as half-miles for checking coal consumption, and on the other hand (II) miles run by their Kitson-Meyer type are correspondingly increased ; in the first case because little or no coal is consumed

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\* Since the above was written this theory has been elaborated in a most interesting manner by Mr. C. J. Morrison in an article on "Maintenance of Equipment Costs on American Railways" (*Railway Gazette*, July 14, 1911), in which it is suggested that the work unit,

$$\frac{\text{average traction effort in lb.} \times \text{average mileage per locomotive}}{1,000,000}$$

may be used as a fair basis for comparison of locomotive maintenance costs.



running down grade and in the second because the K.M. engines use considerably more coal in hauling their heavier trains.

*Average weight of train hauled.*—Another serious defect of “engine-miles” and “engine-hours” is that they do not take into account the weight of the train. A rush of heavy mineral traffic for example might well double the average train load, with the same length of haul, and coal consumption would be considerably increased, while the miles run remained the same. The weight hauled can be brought into the calculation by using what is perhaps the best unit of all for the measure of expenditure, the “gross-ton-mile.” The “gross-ton-mile” is one “gross-ton” *i.e.*, freight and dead weight (the weight of the goods and the tare of the vehicle added together) hauled one mile, and the total of the gross-ton-miles is the total weight (exclusive of the engine) of the trains, multiplied by the distance they have run. There may be some difficulty in organising the preparation of this unit in the locomotive department, but it could be obtained from the traffic department periodically. One of the advantages of the divisional system, under which the whole of the movement of trains is under an “operating” department, is the avoidance of duplication in the keeping of records of train working.\*

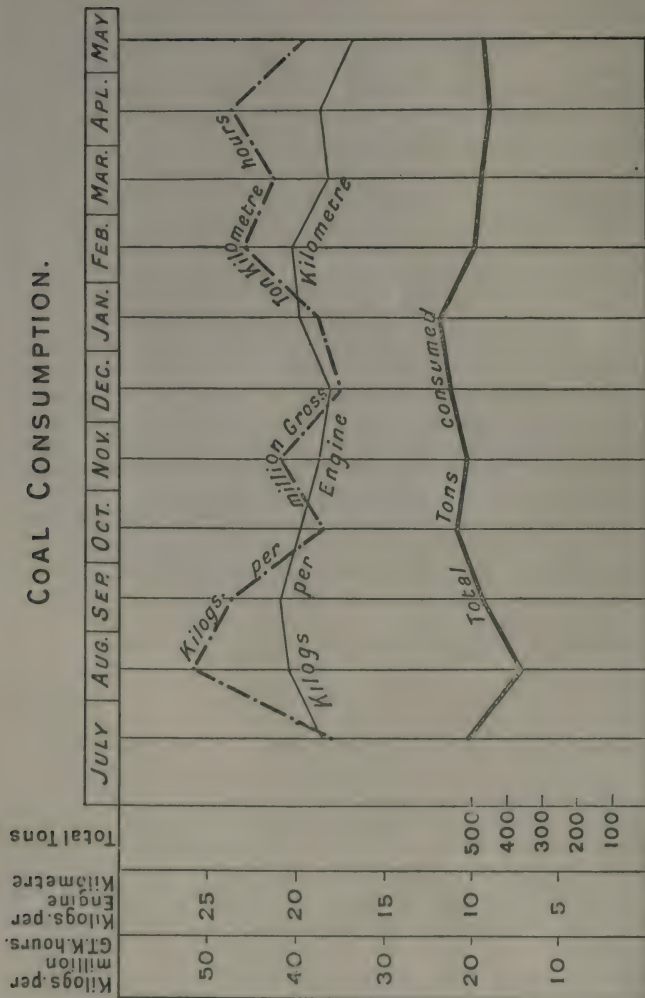
*Gross-ton-mile-engine-hours.*—If the gross-ton-miles are available, they are multiplied by the engine-hours, to produce the G.T.M.-hour, a unit which thus joins the two most important factors of operation, the weight hauled, and the time employed in hauling it; the weight hauled is the work done, and the time, since every engine-hour represents a certain cost in coal and wages, is the measure of how economically that work has been done. This unit at first glance appears to be clumsy, but it may be used as “per million” G.T.M.-hours just as the gross-ton-mile is generally reduced to terms of thousands. It is quite a customary practice in dealing with statistics to reduce a very large unit to a manageable divisor by stating it in terms of millions.

*Coal consumption per mile, &c.*—To illustrate the use of these units, in checking, for example, the coal consumption, the following diagram is given. The points are plotted from actual figures based on the coal consumption of some half-dozen locomotives working a heavy mineral traffic over severe gradients. In these circumstances the consumption ought to be fairly regular, but there are considerable variations, traceable in some cases to a series of engine failures, and again to a lower average train-load.

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\* Report of the Commission on the Central South African Railways.

## COAL CONSUMPTION.



This diagram demonstrates the value of the gross-ton-mile-hour unit, as it is obviously more sensitive. The increase per million G.T.M.-hour in August is not shown by the engine-mile unit, while the latter shows a rise in September which was really a drop, as more weight was hauled for the same consumption of coal. In November there was an increase in average speed with a slightly reduced tonnage hauled, but the consumption of coal did not fall in proportion and there is therefore an increase per G.T.M.-hour, which the locomotive-mile turns into a decrease. A similar effect is observable in April. In February again there was a marked reduction in average weight of train and this is not revealed by the figure per locomotive-mile. In the author's opinion both units should be used, and on the same diagram, so that such contrasts as the above may afford a mutual check. Where gross-ton-miles are not available, engine-hours should be plotted on the diagram, and if possible vehicle-miles. The advantages of graphic representation of statistics can hardly be overrated. A decimal point passes unnoticed in a long row of figures, but assumes its true proportion in the diagram.

*Train-miles per engine, engine-miles per engine, engine-miles per engine-hour.*—The nature of these units is self-evident. The first, owing to its stability, is valuable as a measure of the work done by the locomotives from year to year, and in comparison between different railways, indicates largely the effective user of the locomotives, although this will vary according to the nature of the traffic. The Lancashire & Yorkshire for example, with a large number of locomotives engaged on shunting operations, would not compare well with, say the Brighton line. The same consideration affects the proportion of train-mileage to engine-mileage. The total train-mileage run on the 13 principal British railways during 1909, (taken from the summaries published half-yearly in the *Railway Gazette*) was 329,961,076, and the total number of locomotives owned by the same companies was 19,021, giving an average figure of 17,347 train-miles per locomotive. The Lancashire & Yorkshire, however, only ran 12,158 train-miles per locomotive, against the London, Brighton & South Coast figure of 22,261. This extraordinary variation emphasises the difference which may exist in the nature of the traffic on two different railways, and which must be taken into consideration in comparing results.

*Engine and train-miles per hour per man.*—This unit is described in a paper read before the Swindon Engineering Society, by Mr.

Henry Simpson, in 1906, but the method of compilation is not described and it is admitted that practically the same information is given in the cost "per 100 miles."

*Life between general repairs.*—This is a very important figure, since a "general repair" may amount to 5 per cent. or more of the initial value of the locomotive and may mean the loss of a month or more of revenue earning work. Where impure water is used, or where the engines are "run to death" the general repairs may mean even greater expenditure in proportion to the work done. It is therefore usual to keep a record of this sort :—

No. of engine.	Date entered service.	Date stopped work.	Miles run between general repairs.

This record will furnish the "Average life between general repairs during year in miles" which may be compared with the preceding periods. By taking the totals for five years a very fair average can be obtained, and from this again the "life remaining in locomotives at date" is produced. A combination with the average of the aggregate miles run in one year will give the equivalent "months of service" left in all the engines. This will be quite clear from the following hypothetical example :—

Average miles run per locomotive between general repairs	...	20,000
Less average miles run per locomotive since last general repair	...	10,000
Average miles run per locomotive per annum	... ..	15,000
Average life left per locomotive, miles...	... ..	10,000
Equivalent months of service	... ..	8

This ingenious and valuable unit indicates the state of the department as a whole, and the capacity of the equipment, and when the averages are available for two or more years they form a most valuable comparative figure. When a number of new locomotives are placed in service the "equivalent" months of service will be increased proportionately to the relation between the number of new locomotives and the total stock.

*Expenditure per locomotive.*—This figure represents the total expenditure of the department on locomotives, divided by the number of locomotives owned. It is generally shown in two subheads:—

Running Expenses per Locomotive.

Repairs and Renewals per Locomotive.

but for the use of the department these may again be subdivided into the component parts of the total expenditure, somewhat as follows:—

	Average per month last year.	Amount.		Per engine.		Per 100 miles.	
		19..	19..	19..	19..	19..	19..
<i>Running Expenses :—</i>							
Superintendence ... ..							
Wages ... ..							
Fuel ... ..							
Water... ..							
Lubricants ... ..							
Other Stores ... ..							
Miscellaneous ... ..							
Totals ... ..							
<i>Repairs and renewals :—</i>							
Superintendence ... ..							
<i>Complete renewals :—</i>							
Wages ... ..							
Materials ... ..							
<i>Repairs and partial renewals :—</i>							
Wages ... ..							
Materials ... ..							
Purchase of new locomotives ...							
Workshops expenses ... ..							
Repairs and renewals of machin- ery and plant ... ..							
Other expenses ... ..							
Totals ... ..							
Total expenditure of depart- ment. ... ..							



The author has found a considerable economy and facility of reference to result from the use of a book suitably ruled with the heads of expenditure written or printed on the left-hand half of the left-hand page and the following leaves cut down at the first column, so that these cut leaves can be manipulated to bring any month into juxtaposition with the corresponding period in one or more previous years, and if the book is in manuscript the written headings only require writing in once. This idea is capable of adaptation to many other statistical records.

Mention may be made here of the remarkable series of statistics prepared by Mr. Price Williams, on the subject of Locomotive Repairs and Renewals and published in the Proceedings of the Institution of Civil Engineers in 1909. A summary of this paper with the diagrams appeared in the *Railway Gazette* of September 24, 1909.

#### CARRIAGE AND WAGON REPAIRS.

*Cost of repairs per vehicle.*—The first and most important average figure is the amount spent on each carriage and wagon during a given period. Besides being invaluable to the head of the department, the information is furnished to the manager's office where it is contrasted with the passenger earnings per coach and freight earnings per wagon. The maintenance costs "per vehicle mile" should also be shown.

*Average number and time under repair.*—This is also always stated in the departmental report and should be shown in terms of a percentage of the whole equipment. The time under repair is the proportion of the whole period during which the vehicles have been laid by out of service, or in other words, prevented from earning revenue. The number of vehicles and the time can be reliably expressed in a single unit, "vehicle days out of service," and this may also be stated in terms of a percentage of the total possible vehicle working days. For instance, if the railway owns 1,000 wagons, the working vehicle days in the month of January will amount to 31,000; if one wagon has been three days under repair, two others ten days, and ten others fifteen days, the monthly report will show 173 wagon days under repair, or 56 per cent. of the total vehicle days out of service. This and other information can be shown in the following statement, but the percentage figure should also be compared with preceding periods, to be of value.

Type of wagon	Number under repair on 1st.	Number received during month.	Number repaired during month.	Number under repair on 31st.	Wagon-days under repair.	Per cent. of total wagon-days.
Totals ... ..						

*Vehicle life in miles.*—Some railways keep a separate record for each vehicle of the mileage run, and the dates and extent of repairs. The principal object of this is to ascertain the running life of tyres, axles, &c., but its compilation necessitates a very large amount of clerical work, which is probably not justified by the value of the resultant figures, unless, as in some countries, the data are required by the Government.

#### WORKSHOPS.

The difficulty of controlling the cost of repair and erection work done in the shops lies in the variations that occur in the importance of the work orders received, and in the output of finished work. It is impossible to do everything by piecework and equally impossible to discharge or engage men in exact ratio to the amount of work in hand. Average figures compared from year to year, however, are not greatly affected by these variations.

*Ratio of labour to materials.*—The total cost of repairs to rolling stock and work done for other departments is made up of two component parts, wages and materials, each of which forms a percentage of the whole. Theoretically, as long as prices of material and rates of wages remain the same or rise in unison, such a percentage will remain constant from year to year.

It may, however, be affected by the purchase of more “ready made” material in one period than in another, or by the repairs to boilers exceeding those on frames and cylinders. Taking these items into consideration, the percentage is a valuable index to the cost of work done in the shops.

*Men-days.*—The locomotive superintendent, or works manager, will require a weekly or monthly summary of the wages paid, and this may either show the days worked by each grade, and the wages paid, or be condensed into “men-days,” which are made up of the number of full days work done, *i.e.*, the total hours paid

for, divided by the standard hours per day. This is easily abstracted from the totals of the pay-sheets. The resulting figures might be recorded in the following form :—

	Number of men.	Wages paid.	Total men-days.		Average wages per man-day.	
			19.....	19.....	19.....	19.....
Mechanics ... ..						
Boilersmiths, &c. ...						
Totals ... ..						

The totals show the number of men engaged, the total of the paylists, the average days worked, and the average wage for the whole of the men engaged. This may be conveniently kept in a book of the form recommended for the comparative record of running and repairs expenditure.

#### TRAFFIC DEPARTMENT.

Traffic statistics are generally understood to mean the statistics relating to the handling of the traffic and the revenue derived from the same, but it is also necessary for the traffic superintendent to use statistics for the measure of the internal costs of his department. Where the running department is under the locomotive superintendent, or forms a separate office, the traffic department expenditure, considered purely and simply as departmental expenditure, is comparatively easy to control. The statistical units suitable for the purpose are few.

*Traffic costs per train-mile.*—The most important unit, from the point of view of the traffic superintendent, and for the purpose of measuring the detailed costs of the department, as distinct from the general cost of operation, is the train-mile. Generally speaking, station, signalling, office, and other expenses are the same whether trains run heavy or light, and while it is manifestly the duty of the traffic department to secure good train loads, this is quite distinct from the checking of the expenditure some time afterwards. The following form shows the detailed expenditure compared with the corresponding period in the previous year, and divided by the number of train-miles run. The different

heads of cost are also divided up into their respective percentages of the total earnings, and the classification is based on the new form recommended by the Committee on Railway Accounts for adoption in England.

	Average per month last year.	Amount 19.....	Amount 19. ....	More in 19.....	Less in 19.....	Per train- mile.	% Traffic earnings.
Salaries and wages—							
Superintendence ... ..							
Stationmasters and clerks ...							
Signalmen and gatemen ... ..							
Ticket collectors, porters, &c ...							
Guards, brakemen, &c. ... ..							
Fuel, lighting, water, general stores							
Uniforms ... ..							
Printing, advertising, stationery, tickets							
Wagon covers, &c. ... ..							
Expenses of joint stations and junctions							
Cleaning, lubricating and lighting of vehicles							
Shunting (other than mechanical)...							
Stationary engines, hoists, cranes, &c.							
Coal, &c., tipping ... ..							
Railway Clearing House ... ..							
Miscellaneous ... ..							
Totals ... ..							
Per train-mile ... ..							

*Percentage of total receipts.*—The percentage of traffic costs to the total receipts (or “earnings”) will fluctuate with the amount of traffic carried, but not in equal ratio. An increase in receipts will generally lower the proportionate costs, as the latter are reduced by a greater divisor. Such a reduction does not necessarily mean that expenses are less but that they are less in proportion to the work done. When an average figure, based on results for several years, is obtained, it will be the object of the traffic superintendent to keep his expenditure below that figure, and

when it is exceeded he will at once seek an explanation, which may lie in a decrease in receipts or in an increase in staff or other expenses. The exact whereabouts of the increase is shown in the detail.

*Ratio of cost to receipt per station.*—To trace an increased cost in "salaries and wages" back to its original cause, it is necessary to know where it has occurred, and for this purpose each station, large or small, is called on to render periodically a comparative statement of wages, based on the first portion of the departmental form above, but with the train-mile unit omitted and the number of men in each grade inserted. The total wages will form a percentage of the earnings of the station, a figure which is quite useless for comparison between one station and another, but which will give the indication required to locate any marked increase in the total of the department. The tonnage handled and passengers booked are sometimes preferred as measures of the work done by the station, and the two factors may also be added to make one single unit, counting two passengers as equal to one ton of goods, but this is empirical in the extreme, and the total of receipts is a more reliable figure. Where it is a question of a station exclusively used for passenger or goods traffic, it will be correct to use the number of passengers and tons of goods.

*Loading costs per ton.*—At a large goods station it is necessary to watch carefully the cost of dealing with the traffic handled, and the unit is the number of tons forwarded and received, divided into the wages. The defect of this figure lies in the fact that at some points, especially in England, a large part of the traffic is warehoused, and therefore requires twice handling. The method that naturally suggests itself in this case is to count each ton thus handled twice, as two tons. The extra hoist and trucking work may be ignored. Where there is a large proportion of what are called in England "smalls" (packages under 3 cwt. in weight), a special computation might also be made, since "smalls" generally require special handling and cannot be craned or trucked as quickly as other traffic. With little trouble the average weight of "smalls" can be ascertained, and on this basis a certain number or weight may be taken to represent one ton. Probably half a ton of small fragile packages would require as much time in handling as one ton of ordinary goods.

*Yard cost per wagon.*—Yard costs include locomotive, capstan and horse shunting, besides the wages of shunters, foremen, &c. If the traffic department has its own engine, or is charged with



engine hire by locomotive department, this is added to the aggregate of the other expenditure and the whole is divided by the sum of the wagons received and forwarded, taken from the total of the wagon registers daily. The resultant figure is useful principally as a comparative check on costs during different periods, as the physical conditions of the yards, proximity to main line and engine shed, and other circumstances prevent any reliable use of the unit as between two or several stations.

*Causes of fluctuations.*—When there is a general increase under all heads of expenditure, and the costs per train-mile remain stationary, the inference is that the cost of doing the work has been maintained at the same level. If with a stationary cost per train-mile the percentage of expenditure to receipts show a rise, a preponderance of lower rated traffic may be the cause. If, however, the percentage remain stationary and cost per train-mile rise, an improvement in average loading is indicated. The influence of a large holiday excursion traffic may be evident in a decreased cost per train-mile, and an increased ratio of expenses to receipts, because cheap fares will tend to lower the average receipt, and the closing of goods yards, collieries, &c., will affect freight receipts, while monthly salaries and other standing charges will continue to be paid. The two units afford in this way a valuable check.

The stock argument against the use of these units is that every one is perfectly well aware of the fluctuations long before the statistics are available, and the answer to it is that average statistics not only show the effect of fluctuations in cost that every one is aware of, but also bring to light those that would otherwise pass unnoticed. It is very pleasant to find the month's expenditure down by 5 per cent., but if 10 per cent. less work has been done in train-miles, and 10 per cent. less has been earned, the net result is a balance on the wrong side.

There are certain heads of expenditure in the classification which do not necessarily fluctuate in consonance with the number of train-miles run, but it will be found convenient to divide these in the same way in order that the total of all may furnish an automatic check on the calculations.

An increase in costs per train-mile, if continued over several months, should be investigated. A "slump" in traffic will not be followed in exact ratio by a drop in cost of working, but if the fall is not a temporary one, some reduction will be called for in expenditure, and the necessity of this is exactly what is revealed by the statistical unit.

## CHAPTER IV.

### GENERAL STATISTICS.

#### CLASSIFICATION AND ALLOCATION OF COSTS, &c.

There are some statistical figures which serve as a review of the operations of the railway as a whole, and which do not, therefore, fall under any particular departmental abstract, and are used by the general manager, in addition to those units he may select from the returns submitted by the departments, as conveying the most complete and condensed check on work done and costs. Indispensable to the general manager are the totals of receipts and expenditure, the expression of these per mile of line and per train-mile, and the operating ratio, or percentage of total expenditure to total receipts. All these figures are presented in the form of a comparison with the similar period of the previous year, accompanied by a further statement also in comparative form, showing the receipts from and number of passengers, and receipts and tonnage of freight, and the totals of the abstracts of departmental expenditure. Such information in fact, as will appear later in the half-yearly report. He will, however, require earlier statistics than these, furnished in the form of an approximate traffic return, rendered weekly and containing the bare unaudited receipts from stations. On some railways these are compiled from a daily or weekly return from each station, in which the classes of passengers and principal commodities of goods are classified, a system which places the management *au courant* with respect to the traffic passing at the time. The total of each week's receipts are added to the previous cumulative total for the year to date, which is also a guide to the progress of business. All these returns are indispensable, and are in use on every railway in the world.

Besides the above, it is customary for the general manager to have a monthly report from each head of department, showing the detail of the expenditure in comparison with that of the

previous year, and with each head of expenditure expressed in terms of the unit of work performed by the department, such as, Way and Works costs "per track-mile," Locomotive costs "per engine-mile," and Traffic costs "per train-mile." There is also the Accident Return, in which the number of (I) passengers and (II) employees killed and injured are recorded in (a) accidents to trains and (b) other accidents. The American railways render very complete and instructive returns of accidents, subdivided into different heads of causation. Such a record, even when not published, must be of great preventive value.

Beyond these more or less generally-used statistics, the choice of other units must always depend on the nature of the traffic and the conditions under which the business of the railway is carried on. The general manager may elect to have simply one unit placed before him periodically, such as the wagon-miles per engine-hour, or the traction ton-mile, with other statistics in the background to be referred to as the explanation of variations in the principal figure. Or again, and this is more usual, he may require to have a continuous record, in diagrammatic form, of eight or ten of the principal statistical units of product, and also, in similar form, the departmental costs worked out per train-mile, and per 1,000 gross ton-miles. It will be found convenient to keep in the office of the Administration a record of all the statistics compiled, to be written up periodically in the Accounts Office and used, not only for immediate use, but for reference on the many occasions when questions arise affecting rates, or the working of trains. Such a record should be kept in duplicate, one copy remaining in the Accounts or Statistical Office. The most convenient form of statistical record is the *Analysis of Working*.

*Analysis of working.*—The analysis of working is a dissection of the revenue account into various classified sub-headings under which the receipts and expenditure are expressed in suitable average figures and compound units. The whole forms a complete collection of the statistics of the railway. It is generally kept in a book with columns ruled for half-yearly totals, but may also be used to record the monthly figures if desired. This is the system in force on the Indian Railways and it has manifest advantages; the statistics, being entered in a book, are not filed away and forgotten, and are always available for comparison. An extremely valuable history of the operations of past years is thus formed. It is also usual to print loose sheets containing a comparison of figures for five past years, to bind with the general manager's

report, and in some cases these are also issued to the principal officers of the railway.

In India each item of the analysis is numbered, and the audit office is furnished with printed instructions\* as to the compilation of the various units. Allocation is thus standardised and nothing is left to be remembered, or forgotten, by any individual member of the staff. The progressive numbering facilitates compilation, each item having on an opposite page a reference to the method of its preparation, thus, "19 and 20. The proportions are obtained by dividing item 18 in the ratio of items 73 and 109." The appropriation of various items of working expenses is ordered in the same way by means of footnotes to each abstract. With a standing order book or office manual, such as this, available, staffs of different offices and departments are readily interchangeable, and the absence of one or several clerks or assistants, does not necessarily cause delay.

*Allocation of expenditure.*—It is to be regretted that much of the discussion on railway statistics during the last few years has been devoted to what one writer terms "the eternal ton-mile," when time and knowledge might more profitably have been employed on the consideration of a general standardisation of allocation, or "appropriation," of working costs. It is not of the slightest use attempting to compare the detailed expenditure of one railway with another when every administration follows a different method of charging departmental costs. In connection with working statistics it is not so much a question of what is to be charged to revenue or capital, or of the correct method of writing off obsolete assets, as it is of correctly appropriating actual working costs to one abstract or another. So far as the United Kingdom is concerned, the Railway Accounts Act will bring about some improvement in this respect, especially as it appears to embody the new forms drafted by the Conference of Railway Accountants in 1906. The International Railway Congress meeting of 1910 has produced very valuable reports on accounts and statistics in America and in the British Colonies, in which special reference is made to standardisation. There is now published, therefore, a mass of authoritative opinion which up to two or three years ago was not accessible, and undoubtedly this will have the effect of calling the attention of railway accountants and auditors to existing anomalies.

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\* Indian Government P.W.D. Code, Vol. IV.

Compared with many British and Continental reports, the arrangement of the American expenditure abstracts is very simply and concisely drafted, leaving no doubt under which sub-head a given expenditure should be classified. The importance of uniformity is exemplified by a case that occurred within the author's experience, where the traffic expenditure of two railways of somewhat similar length, traffic, &c., was compared on the basis of the totals given in their respective published reports, with a result which would have formed a serious indictment of the management of one of the lines, had an opportunity not been afforded for a dissection of the items making up the two accounts. The example is rather a remarkable one of differences in classification, as will be seen from the following comparison. It should be added that both the railways, although working abroad, belonged to English companies, and the abstract is simply a copy of the traffic expenditure abstract with the respective amounts divided by each Company's total train-mileage:—

RAILWAY A.				RAILWAY B.			
<i>Amounts allocated in same way.</i>							
d. per train-mile.				d. per train-mile.			
1. Superintendence	...	...	0·57	1. Superintendence	...	...	0·86
2. Stations ... ..	...	...	4·25	2. Stations ... ..	...	...	4·03
3. Trains ... ..	...	...	0·94	3. Trains ... ..	...	...	0·93
4. Printing, tickets, &c.	...	...	0·29	4. Printing, tickets, &c.	...	...	0·57
			<hr/> 6·05				<hr/> 6·39
<i>Amounts not subject to comparison.</i>							
5. Lubrication	...	...	0·61	5. Charged to "Carriages and Wagons"	...	...	...
6. Greasing and examining staff	...	...	0·43	6. Charged to "Carriages and Wagons"	...	...	...
7. Telegraph materials	...	...	0·07	7. Charged to separate abstract			
8. Level crossing gate-keepers	...	...	0·55	8. Charged to "Way and Works"			
9. Wagon Hire	...	...	0·15	9. Charged to "General Charges"			
			<hr/> 1·81	10. Commissions, cartages and compensation	...	...	0·69
10. Deducted from Receipts	...			11. Doctors, medicines and sundries	...	...	0·13
11. Charged to "General Charges"	...		<hr/>				<hr/> 0·82
Total expenditure per train-mile... ..				Total expenditure per train-mile ... ..			
			7·86				7·21

It is quite clear that the totals alone convey a most misleading impression. The train-mile of railway "A" appears to have cost '65d., or over 9 per cent. more than that of "B," whereas when the deduction is made in A's abstract of items charged by



B to some other account the result is reversed and A proves to have spent really less per unit of work done than B. The traffic superintendent of the former line may have been condemned for disregard of due economy, while in truth the difference was only due to anomalies in classification. One of the most important parts of the difference between the two totals is the lubrication of rolling stock. Who should pay for this? The Indian Government include it under "carriage and wagon expenses" together with the examining staff. In the new English form it appears in "traffic expenses" (the wages not being shown anywhere) and in the United States it goes along with other running expenses in "conducting transportation." Some of the Continental lines, and also some British South American railways, show it in "maintenance and running expenses of rolling stock." The perfect method would be the happy mean between the American and English systems, and to some extent this is to be found in the Argentine reports, whose abstracts are as follow :—

Abstract E. Locomotive running expenses.

„ F. Vehicles, running expenses.

„ G. Traffic expenses.

There is no possibility here of erroneous classification of such a large item as lubrication, as it obviously falls under abstract F, together with the wages of the inspecting and greasing staff, and on the other hand it is easy to get at the total of "transportation" expenses by adding the three abstracts together.

The second item in the comparison is that covering telegraph materials. These presumably include repairs to instruments and other movable parts, replenishing of batteries and Morse tape and ink, and here again there is no uniformity in practice. One railway actually charged up telegraph posts to Traffic, while another reversed the process and debited Way and Works with everything connected with telegraphs, including Morse tape and ink. In other reports both operation and maintenance of telegraphs appear in a separate abstract. The correct practice is obviously to treat telegraphs like signalling, and for Way and Works to be charged with maintenance, and Traffic with operation, cleaning, and such loose stores as stationery, ink, and battery replenishment. Level crossing gate-keepers are often charged to Way and Works because such posts are filled by platelayers or their wives, but in point of fact a gatekeeper is half-way between a signaller and a policeman, and has not even a remote connection with the maintenance of the track, unless he be considered as a link in the

fencing. Wagon hire, or "car-mileage" is properly chargeable to Traffic, as it is a true transportation cost, but in the Indian returns it appears in "general charges." Compensation is more generally placed in "general charges," but American practice is to account it as an operating expense. It has also been deducted from receipts, a course which is at least reasonable. Considering, however, that a large proportion of traffic claims arise out of defective equipment, perhaps the allocation to miscellaneous costs is the correct one. Medical attendance, in the case above quoted, has been distributed between the various departments on the basis of the number of individual cases occurring in each, and this is the system suggested by Sir Thomas Rees Price in his report to the Railway Congress. He would extend it also to contributions to sick and superannuation funds, making each department pay for its own individual members, or where the railway contributions to such funds (or to compensation insurance) consist of fixed sums, these are distributed between the departments as a percentage on the wages paid. "Cartage" is peculiar to English railways, and it is undoubtedly an advantage to have it shown separately, and deducted from receipts, as in the new form.

Besides the foregoing, there are the indirect services performed by departments, such as Stores, on behalf of all the other branches. These also have been dealt with by Sir Thomas Price in his report referred to above. The principal items, with his suggestions for their distribution, are as follows :—

1. *Stores Expenses*.—A percentage is added to the issue prices to cover the whole expenditure of the department.
2. *Workshops Expenses*.—Direct expenses charged to actual work. Indirect expenses charged out as percentage addition to the work turned out, including a charge for maintenance and depreciation of machinery.
3. *Electric Light and Power*.—Charged out to departments according to consumption. Cost of train and station lighting charged to Traffic Department.

Stores expenses appear in the Indian returns under general charges, together with Administration and Accounts Office expenses, but for an expenditure which is capable of being so correctly apportioned the distribution over the materials dealt with is obviously preferable. For a small railway a simpler method is to divide the total Stores departmental expenditure between the other departments, *pro rata* to their respective debits for materials supplied, and the same applies to workshops expenses, the total of which may be charged out in proportion to the amount of work done for each department. In this way suspense accounts may be dispensed with.

Enough has been said to show the importance of uniformity in classification of expenditure. It is true that "all the money comes out of one pocket," but in the meagre information often given in railway reports, there is nothing to show the invalidity of a comparison based on the totals only of the different abstracts, and the intelligent shareholder is quick to blame and slow to commend. He is prone to dwell on a high rate of cost under one head and entirely overlook the reduction under another. It behoves, therefore, the general manager to watch very carefully the allocation imposed on his expenditure by the accountant, lest some such anomaly as those referred to above redound unjustly to his discredit before his board of directors and the public.

Statistical results are not only affected by lack of uniformity in classification of costs, but also by the deficiencies of the present calendar. The comparison of any week or month with the corresponding period of a previous year is affected by the variable nature of arbitrary divisions of time. A given month covers five Sundays this year against four last year; an important holiday falls on a Sunday one year and on a week day the next. These, and similar irregularities, tend to vitiate comparisons of traffic results, and the fact of feasts and markets falling on different days and dates in different years adds to the difficulties of forecasting train services. A remarkably simple way has been proposed for remedying these defects of an antiquated system. It is contained in a pamphlet by Alexander Philip, LL.B., called "A Proposal for a Simplified Calendar"\* and consists in the obliteration of New Year's Day from the commercial calendar. This day (as well as the extra day in leap year) would be simply a holiday, and would be otherwise nameless and dateless, January 1 being the day after New Year's Day. This would leave a year of 364 ordinary or working days exactly divisible into 52 weeks and four quarters of 13 weeks each. The day of the week and the day of the month would always be the same, and all calendars would be perpetual. Such an improvement would tender possible a large amount of economy in the preparation of reports and statistics, but its most important effect would be to add to the uniformity of statistical records.

*Statistics of cost.*—The division of the working costs between the several branches of operation has always been a very much debated question, and a great deal has been written on the subject,

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\* Steads Publishing House, 1910.

especially in the United States. It is a question of such wide range as to be outside the scope of the present work, and will only be briefly reviewed here. To the student is recommended the study of the works on railway economics by Acworth, Colson, Dewsnap, Hadley, Ripley, Woodlock, and others.

The aim and end of any attempt at a division of cost between passenger and goods traffic, and between the several classes of traffic, is to arrive at an idea as to whether the rates charged are remunerative, or rather, as it is known from the fact of there being a surplus of receipts over expenditure that the rates do, as a whole, return a profit, to ascertain which of the rates are the most, and which the least, remunerative. What is required in fact is the costs account of the manufacturer, in which each branch of the business is charged with a certain proportion of the expenditure, which, compared with the receipts, subdivided in like manner, shows which are the profitable and which the non-profitable sections of the undertaking. Unfortunately, however, in the case of a railway the matter is not so simple. It is not a question of charging up the costs of one department to one particular class of product. The commodity manufactured by a railway is transport, of varying grades of cost and value. If one line carried nothing but coal and another nothing but grain, and so on, the allocation of cost to the different "qualities" of transportation produced would be quite simple; but it is not so. All the "qualities" are produced on the same line by the same machines, by the same men, and yet they are marked up for sale in the shop window, so to speak, at very different prices. It is partly in the attempt to justify these sale prices (or in railway language, fares and rates), and partly to ascertain the margin of profit resulting from their individual application, that experts have endeavoured to separate the costs of transportation, and to charge each class of traffic with its proportionate share of the total expenditure.

The business of transportation falls naturally into two principal categories, coaching and freight, styled on the Continental railways, fast and slow traffic (*Grande Vitesse* and *Petite Vitesse*), and this forms the first great subdivision for the classification of costs. What proportion of the working expenditure is incurred in the carrying of passengers, and what proportion in the transport of freight? There are certain expenses which can be clearly earmarked to one or the other; the cost of a locomotive running exclusively on passenger service, the wages of guards and brakemen, the wages of the staff at stations which are exclusively used



by one service or the other. All these it is possible to charge at once to their respective places, and there are many other items which it is possible to allocate wholly or in correct proportion to the two categories. Authorities differ as to what amount of the total expenditure may be thus apportioned without recourse to estimating and arbitrary appropriation. Probably 50 per cent. of the whole will be found to be distinctly attributable to either coaching or freight, and even this will vary largely on different railway systems. The remainder consists of maintenance of track and buildings, signalmen's wages, the wages of staff common to both services, and the whole of the cost of account keeping and administration, legal and parliamentary charges and taxes, figuring as "General Charges." It is this remaining 50 per cent. of costs common to the whole of the operations, that forms the difficulty.

Probably the most painstaking efforts to arrive at a correct basis for the apportionment of these unidentified costs have been those made in the United States in connection with the valuation of railway property and the readjustment of rates and fares. One of the formulæ adopted is described in the following paragraph from a paper by J. C. Lawrence, a member of the Washington Railway Commission (\*).

"Several methods of dividing operating expenses between freight and passenger business have been used. A careful examination of the various methods when applied to the same conditions shows a variation of only about 1 per cent. between all of them. The method used by the Railroad Commission of Washington was the simplest of all. Assume that the cost of movement of two average empty freight cars equals the cost of movement of one average loaded freight car, and of two average loaded freight cars equals the cost of movement of one average passenger car. Then reduce the freight car-mileage to the basis of the movement of a passenger car and compare the mileage thus obtained with the passenger car-mileage."

Another method is to charge to coaching or freight all the known items relating exclusively to those services, and to divide the remainder, the "general" expenses or expenditure common to both, between the two in the proportion that coaching and freight train-mileage bear to the total train-mileage. This was the method used by the Pennsylvania Railroad Company in connection with the 2 cent. fare legislation in Ohio.† A similar formula, but carried out to much more detail, is described by

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\* *Railway Gazette*, March 4, 1910.

† *Railway Gazette*, October 30, 1908.



T. F. Woodlock in "The Anatomy of a Railway Report." The basis used is the same, *i.e.*, that of an apportionment *pro rata* to the respective train-mileages. In the method prescribed for the Indian State Railways the total expenditure is divided between coaching and freight in ratio of gross-ton-mileage. This differs from the preceding methods in that no attempt is made to separate the known items of cost; the whole of the expenditure is apportioned on an arbitrary basis. In either case the gross-ton-mile is a more complete unit to work with than the train-mile.

There is still another formula for the division of costs between coaching and freight, this time a French one. It has already been described in the chapter on ton-mile statistics, and is based upon the reduction of the whole of the traffic to "equivalent" ton-miles. By this method it is assumed that the transport of a passenger costs as much as the transport of a ton of freight. The passenger-miles are, therefore, reduced to ton-mileage in the same ratio as the total expenditure bears to the gross receipts. Other coaching traffic is also computed on a similar arbitrary basis, and the aggregate of the equivalent passenger-ton-miles, the computed ton-miles of coaching traffic other than passengers, and the freight-ton-miles, furnishes a figure which represents the total of the traffic carried, in terms of ton-mileage. The total expenditure divided by the aggregate ton-mileage, represents the *cost of the ton-mile*, and this again multiplied by the equivalent passenger-ton-miles and freight-ton-miles produces the proportions of the total cost attributable to passenger and freight traffic respectively.

All these methods are dependent, wholly or in part, on some arbitrary foundation, and the result obtained is, therefore, admittedly not an exact figure. It would obviously be impossible to have a truly exact figure, but there is room for further research in the direction of finding a more perfect theory for the allocation of the unidentified charges.

The application to actual practice of costs subdivided on one or another of the bases quoted will only be undertaken with due regard to the possibility of inaccuracy resulting from the arbitrary method used, but it may be taken for granted that such variation as there may be is fairly constant from year to year, and the final figures therefore provide a very useful comparison between one period or another on any one railway system.

The first use of the costs figures that naturally suggests itself is to compare it with the average receipt. If it has cost 1d. to carry one ton one mile, and the average receipt amounts to 2d.,

the profit is evidently 1d. The passengers may be compared in the same way, and, of course, the two figures of profit multiplied by their respective ton-mileages show the amount of profit on each service, and the total of profit (disregarding for the moment coaching traffic other than passengers and miscellaneous receipts) is equivalent to the excess of receipts over expenditure.

The costs figure may also be used to arrive at an idea of the minimum paying train load. Take the cost of the freight train-mile, either obtained directly by the first method or indirectly by the second (cost per ton-mile multiplied by average tons per train equals cost per freight train-mile). Now if this average freight train-mile cost 60d. and the ton-mile receipt (or "average rate") were 2d., each freight train would have to carry an average load of 30 tons to pay expenses, and the tonnage between 30 and the actual average train-load would represent pure profit. Exactly the same operation may be carried out with the figures for passenger traffic.

It is almost unnecessary to add that the cost per ton-mile is a valuable figure in itself for the comparison of one period with another. Whether the particular method used for arriving at the figure be, theoretically, sound or unsound, the same margin of error exists to the same degree, or fluctuates in direct ratio to the fluctuating elements of the formula, on any one railway system during different periods, always supposing that the same method be adhered to. It is a different matter when a comparison is attempted of the results of two distinct railways, as (*a*) the methods of computation may differ, or (*b*) the elements of the formulæ used may fluctuate to a greater extent in one than in the other.

The possibilities of these statistics of cost have only been touched on in this brief review, and their importance entitles them to much more attention than they have hitherto received, at least in England, from those interested in the practical and theoretical sides of the transportation problem.

## CHAPTER V.

### GRAPHIC STATISTICS, CALCULATING MACHINES, &c., CONCLUSION.

#### GRAPHIC STATISTICS, CALCULATORS, &c.

The use of squared paper is not so common, or at least was not so common a few years ago, as it ought to be, in England, and for this and other reasons it is not customary to present statistics in diagrammatic form, although it will be admitted that any statistics expressed graphically, are very much easier to read, and the comparative importance of fluctuations is much more striking in graphic form than when shown in long arrays of figures. During the last few years some of the magazines have familiarised the general public with this method of producing statistics in an interesting form, although generally as pictorial figures which have not been suitable for the recording of periodical data with slight fluctuations.

"Graphics" are very largely in use on the continental railways, and all sorts of statistics, comparative costs, rates and fares, time-tables, &c., are plotted for the use of the officers and staff in the form of diagrams. The time-table is the commonest form of "graphic," and an example is described to show the value of this form of recording figures. A painted soft-wood board may also be used, with stations scaled off at their respective mileages down each side vertically and the 24 hours marked along the top. The running of each train is distinguished by a thread stretched from a pin stuck in the board at the conjunction of the vertical hour line and the horizontal station line corresponding to its starting point to another pin stuck in the conjunction of the lines corresponding to the time and station of the end of its trip. Passenger trains are indicated by a red thread and goods trains by a black, or various classes of trains may be indicated by different coloured threads. The lines may equally well be drawn on squared paper. On page 73 is an example of the time table on a short

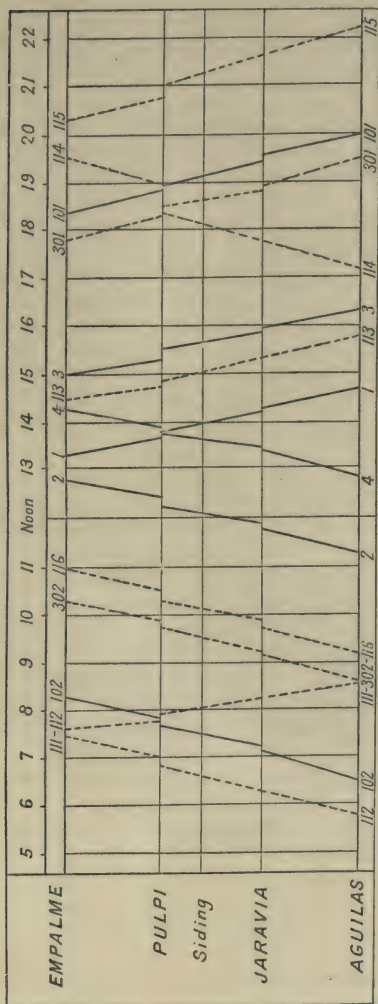
single line branch, the passenger trains being marked by a full line and goods trains by a dotted line.

The author would personally never think of considering a proposal to change a train service without first having the alteration plotted out on the diagram. It is difficult to understand how connections and crossing points can be suitably arranged without it. The best way of making these diagrams is to have a tracing made of the diagram in blank (containing nothing but stations and hours) with fairly thick lines. Then lay over this another sheet of tracing paper and draw in all the present services. A white sun print is now taken off the two together, giving a diagram of the present service, and on this the required alterations can be roughed in. When the new service is finally agreed upon the second or top sheet only has to be redrawn, the first, or blank, diagram, remaining unaltered. In this way also, any particular train or group of trains can be printed out. A parallel rule is required, or a hinged set square, for plotting in new trains. The average speed is first roughly fixed for any section of a more or less normal gradient and the set-square is fixed at an angle which will cover the given mileage in the given time. The set square may now be moved backwards and forwards along the diagram until the point is found at which the proposed train will make the required connections and at the same time not clash with the rest of the service. Or another way is to fix one leg of the parallel rule on any existing train of the same average speed as the one it is desired to introduce, and move the other leg along until it reaches a suitable timing. The new train having been lightly ruled in pencil the parallel rule is again used to fix the speeds between stations. The whole operation, once the blank diagram is made, takes much less time than working out a schedule in figures, and there is no possibility of two trains appearing in the time table as occupying the same piece of line at the same time. On some of the Continental railways a train diagram is published, with a sketch profile of the line shown along the vertical side.

A somewhat similar form of graphic is used on the Great Western Railway for engine working. \*

The monthly totals of receipts and expenditure, and the weekly traffic totals are very often kept in the general manager's office in graphic form, and the fluctuations of business are visible at a

\* Swindon Engineering Society, Transactions 1906-7.



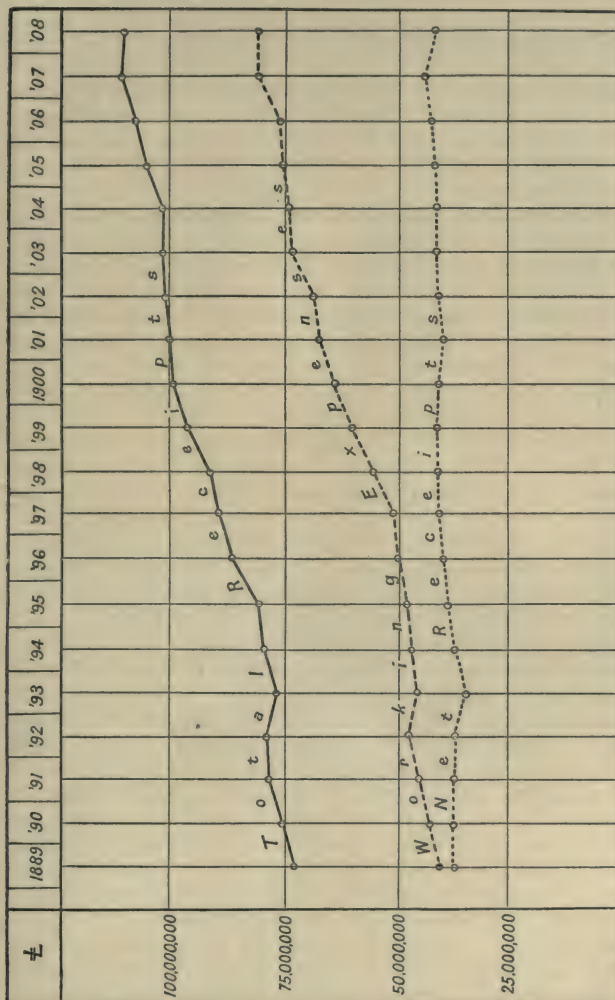
Example of a "Graphic" Timetable.



glance. The author recollects an occasion of great jubilation in the administration of one railway when the line of receipts soared away outside the frame of the diagram !

This form of recording statistics graphically hardly requires description. The months or years, along the top of the diagram, are marked by vertical columns and the amounts stated down the side by horizontal lines, the figures being recorded by dots at the intersection of the two lines. The dots are linked up by straight lines to show the record more clearly. As an example, the diagram on p. 75 shows the aggregate receipts and expenditure of the railways of the United Kingdom for the past 20 years.

It will be obvious from the examples given that statistics shown in this form are very easy to read, and attention is often drawn to variations which would escape observation if presented in rows of figures. The diagram is of no use to the accountant, as he deals in exact figures, but it has never been proposed that accounts should be kept graphically, but only records, and the general manager does not require to know the odd shillings and pence in the total earnings. Nevertheless, it is necessary that the accounts, or statistical office, staff should know how to compile a diagram, in order that the management may be able to call for a given set of figures to be prepared graphically. There is no technical difficulty involved in the preparation of an ordinary diagram. To plot a series of figures, first find the range, *i.e.*, the highest figure it is required to record. Suppose it is desired to show the fluctuations of the expenditure per train-mile in comparison with the train-mile total itself, to discover whether the expenses fall in ratio to increasing train-mileage, over say, a period of 10 years. Squared paper ruled in tenths of an inch should be used. The highest total of train-miles amounts to say 1,000,000, and the highest figure of pence per train-mile to 50. Then the diagram should be about 10 in. high, and every space of one-tenth of an inch represents 10,000 train-miles and every inch space represents 5*l.* ; possibly it will be found that on this scale the variations are too marked and that the "peaks and valleys" are too abrupt to give a readable curve, in which case the index scale should be modified. Practice will show the most appropriate scale to use in each particular case. Graphic statistics are very useful to show the working of cause and effect, as when the fall of one unit coincides periodically with the rise or fall of another. For this purpose any number of lines may be plotted on the same diagram, care being taken to arrange the index scale in such a way



Railways of the United Kingdom, 1889-1908.

as to prevent overcrowding, although all the indices should begin with their zero point at the extreme top or bottom of the square. Differently coloured lines may, of course, be used. A simple example of a "cause and effect" graphic is to plot the receipts from passengers, goods and minerals on the same diagram with the total cost per train-mile. The result will be to show which branch of traffic affects the cost, and to what extent. Of course a sufficiently long period must be selected to avoid transitional or abnormal variations.

Other forms of diagrams are used in the departmental offices, such as the record of "men-days" in way and works and locomotive departments, in which the men-days are shown in thick vertical columns. A very useful diagram also is designed to show the locomotives in service at any given date. The numbers of the locomotives are written down each end of a long sheet of squared paper, and the months marked along the top. A thick black line represents the time in service, and a red line the time under repair. The number in service at a given date is the number of black lines counted vertically under that date. Rates and fares may be very usefully plotted in diagrammatic form, the money horizontally and the stations vertically. A fixed rate of a penny a mile, for example, will form a straight diagonal across the paper. Special rates, however, are often calculated on a curve (generally a curve of the parabolic type), in which the rate per mile is gradually reduced as the distance increases; the English scale of rates for season tickets will be found to produce a curve of this nature. The fixed maximum rates may be traced on a permanent diagram, and alterations plotted in on sun prints when required, as in the case of the time tables.

Examples of the use of diagrams of this sort might be multiplied indefinitely, and it will be noted that those suggested above are simply for the recording of statistics or the investigation of their variations. The preparation of this class of graphic requires no technical knowledge, and the more complicated forms used by engineers are of quite a different nature. For the student of a mathematical turn of mind who wishes to go further into the question there is an excellent book just published, called "Practical Curve Tracing," by R. Howard Duncan.

*The slide rule.*—The slide rule, like the graphic, is not so well known as it deserves to be, partly because of the prevalent impression that it is a technical instrument suitable only for the use of engineers. In point of fact no special knowledge is

required for the use of the rule in ordinary arithmetic, and it can be taught to a schoolboy, as indeed it is in some Continental countries. Like the diagram the slide rule has no place in the accountant's office, as it does not produce exact results, but it is peculiarly applicable to calculations of statistics, especially where it is required to reduce the figures in the accounts to statistical units.

The slide rule dates back to 1633, and simply consists of two logarithmic scales, one of which is made to slide along the graduated edge of the other. Multiplication is performed by the simple addition of the logarithms of the numbers multiplied, and the placing of one figure over another on the rule brings the respective logarithms of those figures into coincidence, the answer being read off opposite the index figure 1. Division is effected by reversing this operation, and proportion, the extraction of roots, and other sums, are also possible. It is not, however, necessary to know anything about logarithms to be able to use the rule. For example, the index on one scale is placed over the figure 2, and opposite the figure 2 on the other is found 4, the product required. In fact the slide rule automatically converts the figures into logarithms, adds them, and turns them back into ordinary quantities. There are several excellent little books on the use of the slide rule, to which the student is referred. The usual form of slide rule, and perhaps the easiest to read, is the Gravêt or Mannheim rule, but the circular form known as the Boucher type, or the "Calculus" sold by Messrs. Halden, are sometimes preferred, as being about the size of a watch they are easily carried in the pocket. There are several other varieties of the slide rule one of which, the Fuller rule, is really a scale of about 40 ft. long wound on a small spiral drum for convenience, and giving a more accurate reading, since the graduations of the scales are much larger. Another is the Anderson rule, which is the same length as the ordinary 10-in. Gravêt rule, but with scales about four times as long, arranged in tiers. A cheap form (1s. 6d.) in cardboard, for the use of students, was introduced a year or two ago, but this will not stand much hard wear and tear. Another calculating rule has been made, with one scale printed in transparent celluloid, and superimposed over the other, but in a sample rule of this form it happened that the celluloid had contracted after printing, and the scales were a fraction of an inch out of alignment. This does not refer, however, to the white celluloid used for facing the boxwood of the Gravêt, which is a great improvement on the old natural wood facing, as the lines are much

clearer. The test of a good rule is that the index figures at both ends should exactly coincide with each other and with the line drawn on the cursor. A cursor with a magnifying glass is now sold, and is of great assistance in reading. It is generally possible to read an answer of four figures on the ordinary rule, but the fourth figure is only approximate, and a possible error of one or two per 1,000 should be allowed for. The whole secret of a profitable use of the calculating rule is to learn to read accurately, which means practice. Once the idea is understood, plenty of practice is to be obtained in applying the use of the rule to daily work. There are many routine calculations in railway offices, outside statistics, which may be performed in this way. Checking pay-lists, for example, or speeds of trains, or estimates; and abroad, where foreign currency has to be translated into sterling, a rough check can be made with great economy of time, as once the rule is set to the rate of change it is only necessary to read off pounds and decimals of pounds on the other scale. But in connection with statistics the slide rule is even more useful. A great many statistical figures, such as percentages, coal consumption per mile, &c., are only taken out to two figures and two decimal fractions. The labour of writing down and multiplying or dividing out the many figures which do not affect the second decimal is therefore avoided, apart from the saving of mental work in the working of the sum itself, and the economy of time. An example will prove this. The Lancashire & Yorkshire total receipts for the last half of 1909 were £3,041,903, and the total train-miles were 9,421,924. What was the receipt in pence per train-mile? To reduce the pounds to pence and divide by the train-miles, is a formidable sum, in figures, but it can be done, and the answer (77·47d.) obtained in 20 seconds on the rule. The percentage of departmental expenditure to total receipts is an even quicker operation, and a third example that may be quoted is the coal consumption per train-mile. Statistical figures of only transient interest are often disregarded because of the labour and time entailed in working out a sheet full of multiplications, but at once become possible if they can be obtained in a few seconds.

There are other slide rules for special purposes. The common photographic exposure meter is an example, and there is also one, sometimes used in railway shops, the Smith-Davis piece-work calculator, which consists of a pair of graduated scales in the form of wheels worked by a treadle. These, however, are not applicable to ordinary statistical calculations.



Although a knowledge of logarithms is not essential to the practical use of the slide rule, it is a great advantage to be able to use logarithms in the compilation of statistics involving very large sums. Multiplication is performed by the addition of the logarithms of the figures to be multiplied, and division by subtraction. The saving of time largely depends on the readiness with which the logarithms of the different original numbers, and that of the answer, can be found in a table of logarithms. When once a certain degree of proficiency in hunting up the numbers is reached, a great economy of time and brain work may be secured. In making up statistics at the end of the month or year, for example, a figure such as the train-mileage will be used many times over, and when the logarithm has been found it should be noted against the figure. For the division of the several departmental expenditures by the train-miles it is then only necessary to refer twice to the table of logarithms in each case, and to make the subtraction, a very much shorter and easier operation than dividing millions of pence by millions of miles. And, moreover, as many fewer figures are used there is not the same liability to error, with the consequent necessity for checking every sum.

*Calculating machines.*—Like the slide rule, the calculating machine is by no means an innovation, as the first adding machines date back to the seventeenth century. Now there are at least 80 distinct kinds of calculating machines, or arithmometers, known. The arithmometer best adapted for railway work is the "Brunsviga," which is a modern development of the adding machine of Thomas de Colmar. Another very practical machine is the Strasser & Rohde arithmometer. Both these machines are as strong and easy to work as the average typewriter. Many of them are in use in the accounts offices of the larger railway companies. The principle of these arithmometers consists in a decimal series of geared wheels, each showing one of its 10 figures through an aperture and connected with a handle by whose revolutions a certain number of movements, corresponding to the number of additions or multiplications required, is conveyed to all the wheels. The saving in time is remarkable. It is claimed that the product of two eight-figure numbers can be got in 6-7 seconds, and the quotient of a six-figure number by one of three figures in the same time, while the square root to five places of a nine-figure number only requires 18 seconds. The answers given are of course exact to the last fraction but it is necessary to use a conversion table for converting

fractions of money and weights and measures into decimals. In any case, for all statistical work, it is convenient to have a table of constants before one, as well as, in countries where the use of the metric system has not yet become general, a table of decimal equivalents of fractions of money and weights and measures.

A remarkable machine has come into use within the last few years for the tabulation of statistics. This is the Hollerith Tabulator, and in principle it records on dial indicators the holes which have previously been punched in a number of cards. These cards are punched in a certain position for each classification desired, and may then be fed into the machine at any time. The machine being set to record a given figure, selects by means of a series of needles (working electrical contacts through the holes) the figure required, producing it as an aggregate on the indicator. The Hollerith machine has been used for some time on the American railways, and also for census records in that country. At least one company in England, the Lancashire & Yorkshire, is also using it.

#### CONCLUSION.

The foregoing chapters are simply an elaboration of a series of notes collected during several years by the author, for the purpose not only of selecting the most suitable statistical units for the measurement of his own results, but also to enable comparisons to be made with other railways. It is aggravating to read a railway report quoting statistics in terms to which one has not the key, and it is hoped that the present work (although its incompleteness is frankly admitted) will furnish such a key. It may also serve as a text book to the students attending the railway lectures which are now given at many large centres in England, as well as to those readers abroad who have not ready access to other sources of information. In railways, as in other business, it pays to give at least a trial to modern ideas, and every railwayman owes it to himself and to his employers to keep informed of improvements in methods for increasing efficiency. That statistics have also a high disciplinary value will not be denied. The author is almost tempted to hope that his work may soon be out of date, as this will mean that some genius has invented the perfect unit, the unit as yet hardly dreamt of, universal in applicability, and of unassailable accuracy.

A rather formidable list of statistical figures has been quoted but it is not suggested that all or any of these are appropriate to

any particular railway, nor is it desired that any one should become a "slave to an average." To quote again from Professor Dewsnap, "There are some happily-dispositioned writers and regulative bodies who see all these difficulties vanishing into thin air when recourse is had to some magical pro-rating basis as train-mileage or gross ton-mileage, or the like. These engineers of philosophy are so much in advance of many of us poor mortals that they have no trouble in determining the roadway maintenance expense due to a 50-mile an hour 500-ton through express passenger train as compared with that due to a 12-mile an hour 2,500-ton freight, stopping, may be, at almost every siding. Their attitude is picturesque, but unconvincing."

But without going to excess it is necessary to have some sort of condensed figure of reasonable accuracy. It is the record of what happened yesterday that helps to a consideration of how to deal with what is to happen to-morrow, and it is impossible to gain a clear idea of what has passed from the scrutiny of countless documents and confusing rows of figures ; hence the use of the statistical unit. No attempt is made to depreciate the value of personal observation ; it would be unwise to sit in an office and pore over statistics while outside matters required attention, but the two methods will run perfectly well together.

Faults which are obvious come immediately under personal observation and are corrected from day to day, while the insidious laxity which occasionally creeps into the best regulated system, will discover itself in the falling-off revealed by the tardy, but relentless, statistical unit.



## APPENDIX I.

### REPORT NO. 1 TO THE EIGHTH SESSION OF THE RAILWAY CONGRESS, BY SIR THOMAS REES PRICE.

BULLETIN OF THE INTERNATIONAL RAILWAY CONGRESS ASSOCIATION,  
VOL. XXIII, No. 12, DECEMBER, 1909.)

#### PART I.

##### **Memorandum by reporter relative to question XIV (II of section 4).**

Railways have become so important a factor in human affairs as almost to warrant the general statement that the progress and prosperity of any country depends on the extent and rate of increase of that country's railway communications and on the wisdom or otherwise of their administration. Any measures which conduce to true efficiency and economy, undoubtedly lead to the extension or extended use of such means of transport.

One of the most valuable aids to efficient management is afforded by comprehensive, well-balanced statistics and accounts, especially if they are available in time to serve the purpose of a guide to current matters. Belated figures usually serve only for purposes of record or criticism; they lose much of their value to the Administration, by reason of their failure to bring promptly to notice the warnings or suggestions which the figures convey.

Since all progress is relative, it is desirable that such statistics and accounts should afford comparisons with other periods or other systems or both, and as it is the case that the main problems connected with commercial railway working (though differing in matters of detail) are more or less the same in nearly all countries, it is clear that the adoption by all railways of uniform methods of recording their statistics and results of working would prove of inestimable value in railway management and administration.

One of the most lasting impressions derived by the writer while on a tour of the various British Colonies, Japan, the United States, Great Britain, and the continent of Europe—an impression which was strengthened by a visit on a later occasion to Egypt and British East Africa—was this international similarity of problems relating to railways and harbours, and the regrettable absence of any system which would render the experience of one country sufficiently and readily available to the other. The possession of such information would over and over again have meant the saving of large sums of money, and would have ensured constantly increasing efficiency and progress. This conviction has only been deepened by subsequent experience and observation.

It is perhaps too much to hope for absolute uniformity in railway statistics in the immediate future since there is such great diversity in the statistical needs of the various railways in different parts of the world, but the discussion by the Conference of the principles of such statistics cannot fail to have a very powerful influence in the direction of securing greater uniformity and utility in the future than has been possible in the past.

So far as the classification of railway working expenditure is concerned, however, the arguments in favour of uniformity are so convincing, and the advantages of being able to institute comparisons between one system and another are so pronounced as to compensate amply for any inconvenience and expense which would be entailed by changes in existing expenditure classifications. It is to be hoped that the deliberations of this Conference will result in the adoption of a recognised standard form of accounts and classification of expenditure for all railways at an early date.

The writer of this paper feels that he can best serve the purpose the Congress has in view by emphasising the importance of securing such uniformity. If, for the purpose of bringing into relief existing differences he



has trespassed on the railway area entrusted to other reporters in order to contrast the practice of other countries with that of British Colonies, his doing so will, it is hoped, not be misunderstood.

## INTRODUCTION.

*Method adopted in preparation of papers.*—In order to obtain information for a survey of the conditions obtaining at the present time in the British Colonies and Possessions, it was necessary to submit to the different Administrations a long series of questions dealing with the two branches of the subject of "Statistics." Information was sought in all from 41 railways, and I have to express my very sincere thanks to the officers engaged in their administration for the large amount of time and trouble taken by them in furnishing the exhaustive information contained in their replies. Particulars of the railways from which information was sought and the extent to which such Administrations have been able to accede to my request for particulars of their practice, are given in the following table.

As might be expected, the railway systems in the British Colonies have in the main followed British practice in regard to the preparation of statistical data, and also in the classification of their working expenditure.

In most cases, such railways are the property of the Government, or the Government has entrusted their operation to a company for a term of years, but retains such a large amount of control in the meantime as to leave the influence of State ownership practically untouched. The capital required for the construction of the lines was in almost every case raised in Great Britain, and the staff was, at the outset, mainly drawn from English railways.

The Governments of the Colonies concerned in the construction of railway lines would, in the first instance, naturally adopt the expenditure heads laid down by Parliament for English railways, rather than frame special heads of their own. With this classification, the staff would be familiar by reason of their English training, and their adherence to it would be a matter of habit. Occasionally, special or local circumstances would imperatively demand some departure from the recognised model, in the shape perhaps of a new sub-head or item of expenditure which did not fit in with the English classification, or public opinion (sometimes expressed in Parliament, sometimes outside of it) would demand a more detailed classification to admit of more efficient control being exercised.

Of late years, other potent factors have been at work in bringing about modifications of the original type of classification in the Colonies.

In the preparation of the attached papers, the writer has naturally been influenced to a considerable extent by South African practice and particularly by methods followed on, and experience derived from the administration of, the Central South African Railways.

In the case of these latter railways, economical working is of especial importance, for the two Colonies they serve (*viz.*, the Transvaal and the Orange Free State) are a long way from the coast, and there is an entire absence of navigable waterways or other means of reliable and cheap transport apart from railways. Consequently, the aids rendered by statistics and other means have been largely availed of. Advantage has also been taken to the utmost possible extent of the experience of other countries in deciding upon the accounts and statistics calculated to best meet the requirements.

The system of accounts at present adopted by the Central South African Railways is partly based on that of the Buenos Ayres Great Southern Railway of South America (which was itself adopted, it is understood, on the advice of a leading firm of British Chartered Accountants) and partly on the classifications issued by the United States Inter-State Commerce Commission, with the addition of French, British, and colonial elements where such seemed well adapted to local conditions.

In analysing the replies received and the information contained in the printed reports received from the different Colonial Railway Administrations, an attempt has been made to adhere, as far as possible, to the subdivisions given in the list of subjects furnished by the Congress, *viz.* :

A.—Principles of Statistics of Railways in operation ;

B.—Uniform Classification of Working Expenses.

But it is obviously difficult to draw a hard and fast line between two branches of a subject so closely related, and in order to facilitate separate treatment, a certain amount of repetition has been unavoidable.

**List of the British Colonial Administrations to which papers of questions were sent showing those from which replies were received.**

ADMINISTRATION.	NAME OF RAILWAY.	Replied to questions.	Furnished reports only.
India and Burma	Bengal & North-Western Railway ...	—	—
	Bengal Nagpur Railway ...	—	—
	Eastern Bengal State Railway ...	1	—
	East Indian Railway ...	1	—
	North-Western Railway ...	—	—
	Oudh & Rohilkhand Railway... ..	—	1
	Great Indian Peninsula Railway ...	—	—
	Madras & Southern Mahratta Railway ...	—	—
	South Indian Railway, Limited ...	—	1
	Southern Punjab Railway, Limited ...	—	—
	Assam Bengal Railway Company, Limited ...	1	—
	Bengal Central Railway Company, Limited ...	—	—
Ceylon, Malay States and Borneo	Bombay, Baroda & Central India Railway... ..	—	1
	H.H. The Nizam's Guaranteed State Ry. ...	—	—
	Burma Railways, Limited ...	—	1
	Ceylon Government Railway... ..	1	—
South Africa	Federated Malay States Railways ...	1	—
	British North Borneo Government Rys. ...	—	—
	Cape Government Railways ...	1	—
	Central South African Railways ...	1	—
East Africa	Natal Government Railways ...	1	—
	Beira & Mashonaland Railways, Limited ...	—	—
	Rhodesia Railways ...	—	—
West Africa	Uganda Railways ...	—	—
	Lagos Government Railways... ..	—	—
	Sierra Leone Government Railways ...	1	—
Mauritius ..	Gold Coast Government Railways ...	—	—
	Mauritius Government Railways ...	—	—
	Cyprus Government Railways ...	1	—
Mediterranean Colonies	Malta Government Railways ...	—	1
	Queensland Government Railways ...	—	1
	New South Wales Government Railways ...	1	—
Australasia	Tasmania Government Railways ...	—	1
	New Zealand Government Railways ...	—	1
	South Australia Government Railways ...	—	1
	Victoria Government Railways ...	—	1
	West Australia Government Railways ...	—	1
South America and West Indies	Trinidad Government Railways ...	1	—
	Barbados Light Railways, Limited ...	—	—
	Demerara Railway Company... ..	—	—
	Jamaica Government Railways ...	—	—
Total ... .. 41		12	11
		Total .. 23	

## PART 2.

## Principles of Statistics of Railways in operation.

## (a) GENERAL.

To the older railway official, few things are more noticeable than the change which has taken place in recent years in the attitude of those engaged in the business of transportation in regard to railway statistics, and the increasing recognition there now is of the value of such statistics as a means of securing the best results in working. Formerly, statistics were regarded as particularly useful in bringing about reductions of staff and in indicating possible economies in other directions, the effecting of such economies being regarded as an end in itself rather than as a means to an end.

At the present time, the value which such statistics of operation possess in securing economical working is still omitted, but more adequate recognition is accorded to the possibilities which any reductions in cost (or increases in efficiency) open up in the way of increased traffic and increased employment of staff. More importance is therefore now attached to statistics of traffic carried, and other figures likely to indicate directions in which expansion is possible.

In this connection, it is necessary to remember that of the total revenue earned by an average railway approximately 40 per cent. is required to meet charges such as interest (or dividends) on capital. Of the remaining 60 per cent., authorities differ as to the average proportion consisting of expenditure which can be readily adjusted to any variation in the traffic offering, as distinct from what may be regarded as fixed operating charges (such as the cost of absolutely necessary material for maintenance or up-keep and the pay of such of the executive and administrative staff, station, locomotive, permanent way, stores, and accounting staff, as must be employed and paid irrespective of the conditions of trade), but one-half may be taken as a fair approximate average. That is to say, the scope for effecting economies in working expenditure does not, on the average railway, usually exceed 30 per cent. of the gross receipts—the rest of the expenditure is more or less beyond the control of those entrusted with actual operation.

This aspect of the question serves to emphasise the advantage of seeking to secure improvements in financial working results by encouraging the development of such traffic as statistics show to be of a profitable nature.

*Object of preparation of railway statistics.*—The object of preparing statistics of railway operation should, in the opinion of the writer, be regarded as fourfold:

- (1) To present a clear idea of the general physical condition of the property;
- (2) To give full information as to the transportation services rendered and the remuneration received for such services, with a view to indicating directions in which it is possible to foster traffic;
- (3) To indicate the cost of doing the work and the directions in which it is possible to reduce such cost without detriment to efficiency;
- (4) To indicate the social and economic aspects of operation as affecting the public in general and the staff employed in particular.

*Accounts and statistics: relation between.*—While it is true that the figures recorded in the accounts of a railway form an important section of the statistics necessary for efficient administration and are the basis of some of the other statistics as well, it is the opinion of the writer that a clearer distinction than is usually made should be observed between the respective spheres of accounts

and statistics, and in this paper an attempt has been made to separate matters of account from those statistics which are usually prepared for the special assistance and guidance of operating officers.

The latter class of statistics may be aptly divided into two sections, viz.:

- (1) Temporary;
- (2) Permanent.

*Temporary statistics.*—The temporary statistics are in a measure approximate, and consists of details obtained from day to day or from week to week, to guide the officer while operations are in actual progress—as examples the following are given:

Statements of approximate weekly earnings;

- “ “ (received) traffic on hand at stations (daily);
- “ “ traffic requiring transport in through and in local service (daily);
- “ “ train loads (tonnage) in comparison with haulage capacity of engines (daily);
- “ “ weight of traffic in vehicles in comparison with capacity of such vehicles (weekly or monthly);
- “ “ train and vehicle-mileage (weekly);
- “ “ train and wagon-miles per engine hour (weekly or monthly);
- “ “ trucks under load at stations (daily);
- “ “ rolling stock on hand (daily).

*Note.*—In connection with such statistics, it is of interest to note that the controversy some few years ago as to the relative merits of ton-mileage statistics (as compared with the particulars on which English railway managers relied) was probably due to the failure to recognise the necessity for temporary statistics. The value of properly prepared ton-mileage records is, in the writer's experience, undoubted. But at best the records can only be available some time after the traffic has been carried, and in the meantime, the needs of the operating officials require to be met by means of temporary statistics.

*Permanent statistics.*—The permanent statistics, on the other hand, comprise actual ascertained results collected and presented as early as may be possible for scrutiny, enquiry, and consideration after the operations are over. These statistics are especially valuable if they enable comparisons to be usefully made with earlier periods or with results attained on other lines. If the interval between the operations they record and the time of their presentation is not long, they are extremely valuable to the Administration as a record of what has been accomplished. They often also indicate directions in which it is possible to attract profitable trade and to curtail avoidable expenditure, without sacrifice of efficiency. If judiciously prepared and well balanced, they are especially valuable in enabling the Administration to form a judgment in regard to such matters as proposals for additional facilities to the public using the railway, inasmuch as they serve to indicate whether such additional services will be remunerative or not.

They should also be concise and to the point, for as a rule, the administrator of a railway has the current operations of his lines to attend to, and gets but little leisure time in which to digest voluminous statements. What is placed before him should render it possible for him to take a survey of the month's operations and take cognisance of any salient features without the expenditure of much time.

To secure this, it is essential that the preparation of such statistics should be entrusted to trained officers who fully recognise that their purpose is not so much to serve criticism as to guide and help the administrators in their work of supervising operation—work which is at best both arduous and harassing.

It is scarcely necessary to add that those on whom the duty of preparing or scrutinising the figures rests should be keenly alive to the importance of



bringing to notice facts which indicates possibilities of increasing the traffic of the lines or securing better results of operation or increased comfort and contentment of the travelling public and the railway staff.

Similarly it goes almost without saying that one set of statistics, however valuable, without the corrective supplied by others, cannot fail to lead astray. For instance, statistics based on train-mileage alone may often give an impression which is at variance with actual facts, and ton-mileage statistics are themselves of limited value without figures of train-mileage, earnings, tonnage of traffic (and its direction) at certain principal stations or districts. Such figures must be supplemented also by knowledge of traffic and working considerations, which can only be partly expressed in statistics.

Subject to the foregoing general observations, a somewhat detailed analysis of the principles on which the statistics prepared on British Colonial railways are based, together with information as to the statistics which the experience of the working of the railways under the charge of the Reporter, has indicated as the most suitable, is submitted for the consideration of the Congress.

### (b) ACCOUNTS.

The construction and equipment of a railway involves considerable expenditure. It is essential that proper records should be kept of the money raised for, and the expenditure involved in, bringing the line up to the stage when it begins to earn revenue and in carrying out any subsequent extensions or substantial improvements. It is equally important when the line is opened that proper accounts should be kept of the earnings from operation and of the working expenditure, interest, and all other charges, as well as of the resulting profit or loss, as the case may be.

As has already been pointed out, the accounts of a railway form the foundation of much statistical data, and the importance of securing, at the outset, such a uniform system of accounts as will readily admit of the preparation of such statistical data is worthy of careful consideration.

*Nature of railway capital expenditure.*—If the items of capital expenditure in connection with railways are analysed, it will be seen that they fall under fairly well defined heads, namely:—

- (1) Permanent way, works, and accessories (including station buildings);
- (2) Equipment: engines and rolling stock;
- (3) General buildings, workshops, offices, stores, &c.;
- (4) General expenses and cost of raising capital.

In addition to the above there is, in the case of many railways, capital expenditure in connection with such outside operations as docks and wharves, hotels, grain elevators, &c., which should be kept distinct from railway capital expenditure proper.

*Form of capital account.*—The Capital Accounts of very few colonial railways give particulars of capital expenditure. Sometimes, however, the capital cost of each of the different sections of the line is shown, such items of capital expenditure as are common to one or more sections being pro-rated on some arbitrary basis.

While the desirability of keeping records of capital expenditure under sections cannot be questioned, it appears to the writer that such sectional records should be subordinate to the main statement of capital expenditure, which would show the totals of the different items making up the cost of the railway system (such as permanent way, works, equipment, &c.) in such order as will facilitate analysis under sections.

In considering to what extent records in detail should also be kept of the cost of particular works, equipment, and appliances, regard should be had to the fact that, notwithstanding the most liberal provision for maintenance and



repair, capital assets of almost every nature, except land, are subject to deterioration, and if the capital account of an administration is to remain accurate, it is absolutely necessary to keep proper records of the cost of each class of such assets. By this means only can the necessary adjustment be made when the asset goes out of service or is condemned.

*Balance sheet.*—That comparatively few British Colonial railways prepare a regular "Capital Account" and "Balance Sheet" showing their financial position, is probably due to the finances of the railways being more or less intimately bound up with those of the colony itself. The value of such statements in connection with the study of railway working is so considerable, that the writer is induced to subjoin draft specimens\* of forms based on accounts actually prepared in British Colonies, so as to bring under discussion the question of the standardisation of railway accounts and returns of this nature.

In the case of many British Colonial railways, the complete adoption of standard forms would not be possible without more or less divorcing railway accounts from the ordinary Government accounts, but on the Central South African Railways, this step has been taken with results which leave nothing to be desired, either from the standpoint of the Government or the Railway Administration.

*Revenue account and net revenue account.*—The importance of setting out clearly the earnings and expenditure of lines open for traffic is generally recognised throughout the British Colonies, but unfortunately there is a want of uniformity in the manner of doing this. To begin with, there is no common understanding as to the heads under which either earnings or expenditure shall be kept. In some cases, earnings are made to include the receipts from departments worked by the railway which are not strictly a part of the ordinary services of transportation. Again, some Administrations show under "Earnings" only *cash actually received* (a practice adopted from English Government accounts), while others, correctly, record their whole earnings, whether such earnings have been actually received or not.

In regard to the recording of expenditure, similar diversity of practice exists, and will be dealt with in detail later on in the course of this paper.

No uniformity can be attained and no useful comparisons can be instituted between one railway and another, unless some general principles are adopted which will eliminate at any rate the most serious differences in present practice. The following proposals are submitted for consideration:—

- (1) That each Administration should keep a "Revenue Account," which would be *credited* under suitable heads with amounts earned (whether collected or not) for services directly and necessarily connected with transportation by rail; *debited* under suitable heads with the cost (whether actually paid or not) of maintaining the railway and the equipment, of working the traffic, of management, and of other services directly and necessarily connected therewith.
- (2) That each Administration should keep a "Net Revenue Account" and an "Appropriation Account." These accounts would be dealt with as follows:—

NET REVENUE ACCOUNT would be credited with the gross profit over working expenses (brought from the "Revenue Account" referred to in (1) above) and would also be credited or debited with the following items according as same represent profit or loss:—

- (a) Net profit or loss on lines leased.
- (b) Net profit or loss on working of cartage department, catering department and hotels, steamer services, tramway services, bookstalls, house property, other separate departments which are in the nature of outside investments.

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\* See Part 5.

- (c) Interest earned on investments (credit).  
Interest paid on fixed railway loans (debit).
- (d) Bad debts and losses written off (debit).

APPROPRIATION ACCOUNT would be *credited* with :—

- (1) The balance of net profits shown in the Appropriation Account for the previous year.
- (2) The profit for the current period as shown in the Net Revenue Account above referred to.

It would be *debited* with any amounts appropriated from profits for such purposes as :—

- (a) Improvements of railway property ;
  - (b) Redemption of capital or loans ;
  - (c) Acquisition of new capital assets (capital expenditure from profits) ;
  - (d) Dividends to shareholders.
- (3) That any refunds of revenue should be deducted from the revenue affected and not be shown as expenditure.
  - (4) That any expenditure of a recoverable nature should not be included as part of the expenditure shown in the Revenue Account or the Net Revenue Account but debited to a suspense Account pending recovery.
  - (5) That where rolling stock is hired from or loaned to another administration, on payment, the net earnings or expenditure only should be shown in Revenue Account.
  - (6) That expenditure on such services as relaying large sections of a line, replacing buildings, renewals of locomotives and rolling stock, should either be provided for out of Renewals Fund created and maintained by the inclusion in the working expenditure accounts of regular charges for depreciation (preferably under a separate head or separate sub-heads) or should be recorded separately under each head of working expenditure shown in Revenue Account.
  - (7) That any revenue represented by charges raised for haulage of the administration's stores and material over home lines should be shown separately in Revenue Account and not included under the ordinary heads of traffic earnings. The advantage of creating debits for all such services as a check on unnecessary haulage is undoubted.

Specimen forms of Revenue, Net Revenue and Appropriation Accounts which will serve to explain more clearly what is suggested are attached.\*

## EARNINGS.

The main sources of railway revenue are :—

- (a) The transport of passengers (with their luggage) and goods (including live stock and minerals).
- (b) Other services not so directly connected with transportation—such as storage, cloakroom receipts, &c.

Such a division of earnings would be inadequate for any except the very smallest administration. It is somewhat important, however, that it should form the basis of a more extended classification, since it distinguishes clearly between those earnings arising directly from the conveyance of traffic and those which are more or less incidental thereto.

*Classification of traffic earnings.*—A logical method for the further subdivision of transportation earnings is indicated by the different quality of the services rendered in connection with the conveyance of the traffic. Passengers, their luggage, mail matter, and parcels are usually carried in

\* See Part 5.

trains running at higher rates of speed; the stations and vehicles provided are usually of more costly construction and both earnings and expenditure in connection with the traffic are high in comparison with those for the conveyance of other traffic.

If any idea at all of the relative profitableness of the different classes of work done by an administration is to be obtained, the accounts should record separately the receipts for services performed by passenger trains as distinct from goods trains.

Then again, the earnings of goods trains must be subdivided where the traffic is at all large, the extent of the subdivision varying according to the nature and volume of the traffic carried. Differences in the vehicular accommodation provided and the existence in one case, and absence in another, of special expenses in connection with conveyance would suggest as natural the following subdivision of the goods earnings:—

- (a) Live stock
- (b) Goods;
- (c) Minerals.

*Classification of earnings incidental to traffic.*—The subdivision of earnings from operations not so closely connected with the conveyance of traffic might quite well be effected so as to conform to the same general order as the subdivision of the previous main head, *i.e.*, the first-class would be earnings, which are more particularly connected with the coaching service, and the second, those earnings which relate rather to the goods service. A third subdivision would consist of those earnings which are quite general in character, and do not specially pertain to either the passenger or goods services.

## EXPENDITURE.

*Expenditure.*—The second part of this paper deals with the classification of railway working expenditure, and it is only necessary to mention here such general principles as appear to be essential to the preparation of “unit” statistics (that is, statistics such as the cost of any particular service per ton, per open mile, per train-mile, &c.).

A perusal of the replies received from the various Colonies makes it apparent that the uniform observance of a few cardinal principles in the classification of expenditure would not only be of general advantage as admitting of ready comparisons between one railway and another, but would give each Administration, at trifling cost, information as to the working of the lines controlled, which could otherwise only be obtained by the preparation of special returns or statements at considerable cost. Moreover, the adoption of such principles would render easier the preparation of other statistics of railway working.

The position of a railway is that it has transport to sell, and its interest lies in disposing of it in the manner best calculated to yield the largest net revenue, due regard being had to other considerations always present with a good seller.

To arrive at this result, it is obviously necessary to know, as accurately as may be possible, the cost of each service that goes to make up in the aggregate the performance of transport, and the preparation of such information can be much more accurately and readily obtained if expenditure is classified *according to the nature of the services rendered* and not according to departments. If this principle were adopted a clear distinction would be drawn between:

- (a) Services directly connected with railway working, *i.e.*, the service of transportation;
- (b) Services not directly connected with the actual service of transportation (such as cartage, catering, hotels, &c.).

On most railways from which replies have been received, subdivision of expenditure is effected according to departments (following the usual English practice). Radical changes have already been made in the organisation of certain British Colonial railways. The position at the present time is that some services which are in one administration performed by one department are in another entrusted to quite a different department, and any comparisons between railways with different types of organisation are consequently rendered either impossible or misleading. As the classes of work to be done on railways are more or less the same all over the world, these seem to afford by far the best divisions of the expenditure. If adopted, they would give the following as the main heads of railway working expenditure:

- (1) Maintenance of the permanent way and works, bridges, station and other buildings used in connection with the operation of the line, fencing, telegraph lines, signals, &c.;
- (2) Maintenance of equipment, *viz.*, locomotives and rolling stock;
- (3) Transportation and Traffic: expenditure for working and supervising the traffic;
- (4) General Administration: charges common to all services connected with the working of the railway.

The subdivision of such heads of expenditure would be effected so as to reflect as far as possible the cost of the different services rendered, special importance being attached to grouping items and sub-heads according to the proximity of the service to the actual conveyance of traffic.

The same observations apply in respect to subsidiary services undertaken either to make transport more attractive to the buyer, or else to procure revenue in diminution of the cost of carrying out the work, (including such services as catering and refreshments and advertising at stations).

#### (c) STATISTICS OF PHYSICAL CONDITION OF PROPERTY AND EQUIPMENT.

*Capital assets, Statistics of.*—As has already been mentioned in connection with capital account, it is important that records should be kept of the principal capital assets of a railway administration, and it is desirable that any statistical data prepared from such records should give an idea of the condition and, if possible, the value of such assets. The greater number of the British Colonial railways recognise this, and give full particulars of the mileage owned and operated and the accessories and equipment used in connection with such operations. The amount of detail given varies with almost every administration, but an analysis of the various statements furnished appears to indicate the desirability of compiling periodically the following information:

#### PERMANENT WAY AND ACCESSORIES.

*General Statement*, showing cost, length, highest point, steepest gradient, radius of sharpest curve, ruling gradient when fully compensated for curves, and average cost per mile of each line (excluding general workshops, general offices, and rolling stock).

*Mileage Owned*.—Statement showing separately the mileage of single, double, and treble track, and of sidings, also the equivalents in single track mileage for each section of the line.

*Average Mileage Operated*.—This information is required in connection with the preparation of other statistics.

*Rails in Track*.—Statement showing for each section the mileage of rails of each class according to weight, length, and date when laid.

*Sleepers*.—Statement showing for each section the mileage of each class of sleepers, the number laid to the mile, sizes, and ages.

*Rail Fastenings*.—Statement showing mileage of each type and ages.



*Ballast.*—Statements showing the mileage of each line according to the nature, depth, and width of the ballast used.

*Bridges.*—Dimensions, capacity, and cost on each section.

*Reservoirs and Dams.*—Particulars of capacity, description, number, site, and cost of construction for each section.

*Pumping Plant.*—Particulars of and cost for each section.

*Coaling Plant.*—Particulars of and cost for each section.

*Station and other Buildings used for Railway Purposes.*—Particulars for each section, under classes, giving cost.

*Signalling Appliances.*—Particulars for each section, under classes, giving cost.

*Telegraph Lines and Instruments.*—Particulars for each section, under classes, giving cost.

*Land acquired for Railway Purposes.*—Under sections, giving also cost and dimensions.

### EQUIPMENT (ENGINES AND ROLLING STOCK).

*Locomotives, Particulars of.*—Giving under separate types the following information:

Number of each type, tractive power, average weight (engine and tender in working trim), average cost per locomotive, dates when placed in traffic, condition, number of obsolete engines on hand. (Such statement should show against each type the additions and reductions during the period covered and particulars of any conversions. For any engines which have gone out of service the mileage run to date of condemnation should be stated for each class.)

*Coaching Stock, Particulars of.*—Giving for each description the number of vehicles, average age, average seating capacity, average tare, average cost. (Similar information as in the case of locomotives should be given as to additions and reductions, conversions, and mileage run by vehicles taken out of traffic.)

*Goods Stock.*—Similar particulars to those set out above for coaching stock (including average load capacity and average tare).

*Workshops and other Plant and Machinery. Particulars of.*—Giving description, age, and cost of plant owned; also of any additions or reductions during the period covered.

It is particularly important that, either in the above statements or in special statements, the condition of the equipment should be periodically brought under review. It is not sufficient indication of the actual position to show that there are so many engines and so many cars, unless the proportion or numbers in good, indifferent, or bad condition is also stated.

Statements of this nature (especially where condition and cost or value is given) exercise a salutary influence in securing that there shall be no long continuance of deterioration of capital assets, without the proper adjustments being made in capital account, or the assets being again placed in serviceable condition at the expense of working charges.

### (d) STATISTICS OF THE VOLUME AND CHARACTER OF THE TRAFFIC CARRIED.

*Passengers: number and revenue.*—Most railways give statistics of the numbers of passengers carried (usually also of the numbers availing themselves of each class of accommodation provided) and the revenue earned for their transport. Where the railway connects with the lines of other administrations, separate records are as a rule kept of the numbers and earnings in respect of the different classes of "through" (*i.e.* foreign) passengers exchanged with such other lines. Often also separate records are kept of the "up" and "down" passenger traffic.



The necessity for such statistics is self-evident. They enable those directing the services to gauge the public demand for facilities of different classes, and they afford information as to the probable financial and other effects of alterations in the scales of fares, in the types of vehicles used, and of any acceleration or increase of train service, &c.

To what extent particulars shall be kept will of course depend on the magnitude of the traffic carried. Some of the railways in the British Colonies keep statistics of passenger numbers under seven or eight heads, whilst others keep them all under one general head. The only rule which seems to admit of general application is that wherever there is a very considerable difference in the rates charged for conveyance of separate classes, it is advisable to keep separate records of the volume of traffic and earnings under each.

*Luggage and parcels.*—Luggage and parcels are usually carried by passenger trains, and in order that the earnings of the coaching service, as distinct from the goods service, may be ascertained, it is desirable to keep separate records of the weight of such traffic for comparison with the earnings. In many cases, separate records are kept of luggage and of parcels, and this information is sometimes found of particular value in connection with the arrangement of train services and the fixing or modification of luggage or parcel rates.

*Other passenger train traffic.*—Where mails, or such commodities as milk, are usually carried in large quantities by passenger trains, it may be necessary to keep a separate record of the weight and earnings under a special sub-head, but in the majority of cases all that would seem to be required is to have a general head under which miscellaneous revenue of passenger trains would be recorded with a view to arriving readily at the total earnings of such trains.

*Goods and minerals.*—What has been said with regard to coaching traffic, applies equally to traffic carried by goods trains or by goods vehicles on "mixed" trains. It is essential to efficient management and control that separate records should be kept of the tonnage of the most important commodities carried. If, against the tonnage of such commodities, the revenue earned can also be given, the statements become still more valuable.

*Traffic: direction of.*—The importance of a distinction in the records between "through" and "local" traffic, and between traffic carried "up" or "down," or "north" or "south" or "east" or "west" (as the case may be) of course varies with local circumstances, but in cases where the heavy traffic is in one direction, it is of undoubted value to have separate figures for the traffic in the two directions. Where there is the element of competition with other railways, it may be necessary or desirable to show separately the quantities and earnings of goods consigned to or from the areas where such competition is felt.

*Commodities carried: classification of.*—To suggest for general adoption by all administrations a detailed list of commodities, so that the tonnage of each carried might be stated in a uniform manner would no doubt be futile at the present time, but the writer would commend to the notice of those interested in the subject the general heads under which commodity statistics are prepared by all railways in the United States of America. The advantages in the matter of comparison of railway statistics if these or similar heads were adopted generally by railway administrations will be readily seen.

- (1) Products of agriculture;
- (2) Products of animals;
- (3) Products of mines;
- (4) Products of forests;
- (5) Manufacture and miscellaneous.

In the records of the Administration with which the writer is connected, the tonnage of and earnings on coal traffic (which in point of tonnage represents more than one half of the traffic) are shown under a separate head, entirely distinct from the figures of goods traffic and earnings (which latter include all minerals other than coal). While this practice may not be entirely suitable for other administrations, it would appear to be a matter worthy of consideration whether the adoption in railway accounts of a separate head of earnings for "Mineral Traffic" would not be of general advantage.

Another distinction that should be reflected in any tonnage statements is that between public traffic and railway service traffic.

(e) UNIT STATISTICS AS APPLIED TO VOLUME OF TRAFFIC CARRIED,  
TRAFFIC EARNINGS AND UTILISATION OF ROLLING STOCK.

*Statistical units.*—To admit of the ready grasp of the meaning of figures showing the volume and earnings of passenger and freight traffic, as well as the expenditure connected with railway working, railway managers have long been in the habit of expressing the recorded results in terms of some unit, as an average or a percentage. As is natural, most railway units take into account the element of distance as well as that of weight or number. Thus we have units based on distance and

Equipment used	...	...	...	...	{ Train-miles. Engine-miles. Vehicle-miles
Number	...	...	...	...	
Weight	...	...	...	...	
					{ Passenger unit miles. Ton-miles.

*Train-mileage.*—An idea of the actual services performed in connection with the transportation of traffic is given by statistics of the train-mileage run, but such information requires to be supplemented by other statistics, and by a general knowledge of working conditions before it can be put to much practical use. Train-mileage figures are usually given for each of the two main divisions of traffic, *viz.*, coaching and goods, but in the case of large administrations the train-mileage is subdivided into further classes. Under coaching train-mileage, for instance, some administrations show separately the train-mileage of fast and slow passenger trains, and the mileage of excursion trains. The extent to which subdivision is necessary depends, of course, on the individual requirements of each administration. The basis for division is indicated in most cases by some marked difference in the services rendered, or in differences in the expense of running particular classes of trains.

Most British Colonial Railway administrations make extensive use of the unit of train-mileage in their records of operation. Usually the earnings, as a whole, are worked out per train-mile ("up" and "down") for (a) passenger trains and (b) goods trains, but in some cases only, the average earnings per train-mile are given without any distinction being drawn between the two services. Needless to say, the latter information, while giving a general figure of considerable value, is inadequate except for small administrations. Where the train-mile earnings for coaching traffic are shown regularly under classes, a valuable indication is given as to the necessity or otherwise for adjustment of the train service, or of the scale of fares. Where the average earnings per train-mile show a constant downward tendency, one might be obliged to think of cutting down the service.

Similarly with the goods and mineral train services, the earnings per train-mile constitute a valuable record for purposes of control.

*Passenger-miles and ton-miles.*—The most comprehensive measure of earnings and services rendered is afforded by statistics of passenger unit mileage and traffic ton-mileage. Such unit mileages in themselves express the actual amount of the work involved in the transportation of persons and material almost as clearly as a statement of the energy required to lift a certain weight is expressed

in the physical sciences by the number of "foot-pounds" (that is, the weight of the material multiplied by the number of feet it is to be raised). Theoretically we have in passenger unit and ton-mileage statistics, what is perhaps the most satisfactory common measure of railway work which could be devised. While a train or vehicle, and a train-mile or vehicle-mile, may and does differ on one administration from the same unit on another administration (or even on the same administration at different dates) the service of moving a passenger or ton of goods one mile affords a basis for a more accurate comparison, whether such comparison is with another administration or not. Such figures are, however (as has been already pointed out) of very limited practical value unless taken in conjunction with other statistics of operation—by themselves they are often positively misleading.

To a considerable and increasing extent, passenger-mile and ton-mile figures are prepared by British Colonial Railway Administrations. Some prepare two sets of ton-mile figures, one giving for both passenger and goods traffic the "gross" ton-mileage (i.e. including the ton-mileage of the passenger and goods vehicles themselves as well as of their contents) and the traffic ton-mileage. The gross ton-mileage is a good index of the physical work performed, and the information affords a satisfactory basis for division of certain classes of expenditure between sections or different services, such for instance, as the division of certain *general* expenditure between passenger and goods services. Where gross ton-mileage is taken out, the weight of passengers, live stock, &c., is in the British Colonies generally arrived at by multiplying the numbers carried by average (estimated) weights of passengers, &c.

*Zone statistics.*—Where, by reason of the cost or otherwise, ton-mile figures cannot be prepared, statements of the numbers of passengers and tonnage of goods, according to the distance carried in zones, say:—

From	1 to	10 miles,
"	10 to	25 "
"	25 to	50 "
"	50 to	100 "
"	100 to	150 "

and so on, giving the average earnings per ton for each zone, and for different commodities, will be found to be almost as valuable as the average earnings per passenger unit or per ton-mile. For purposes of rate making or adjustment, such figures are—in the opinion of the writer—even more valuable, as it is possible from the statements to gauge at once the financial results of a reduction in rates for long or short distance traffic in any of the classes for which the records are kept.

*Average haul.*—With the figures of passenger unit-mileage and ton-mileage are usually given particulars of the "average distance haul" for passengers and for goods—information which is not nearly as valuable as the statistics of the traffic under zones to which references is made in the preceding paragraph.

As a general indication of the rise or fall in earning power of their lines, most British Colonial Railway administrations give the earnings for passengers and freight per mile of line. Such information is more valuable when taken out for the different sections of the line, so as to reflect the development of particular districts. Such figures are occasionally valuable when projects are under consideration for the construction of new lines in districts where the conditions are similar.

*Train loads.*—Some of the uses of engine, train, and vehicle-mileage statistics, have already been referred to, but perhaps the most important direction in which such figures are useful is in securing the efficient loading of the rolling stock, and also in getting the maximum amount of work out of such stock. The latter should perhaps come first, for the expense of providing engines and rolling stock represents a large proportion of railway

capital expenditure; how large the proportion is of the whole must ultimately depend on the efficiency with which the engines and rolling stock are utilised. To get the maximum amount of work out of a given quantity of rolling stock means that fixed charges, such as interest on capital expenditure for rolling stock, are kept down to the lowest possible figure.

The great thing is to keep the stock employed to the fullest possible extent in hauling traffic; never to incur light mileage where it can be avoided, and to keep the stock moving and earning money. The minimum of cost cannot be secured unless good engine loads are arranged with trucks loaded as nearly as may be to their full capacity, and passenger cars to the full extent which the accommodation permits.

So far as the use of such statistics more directly bears on the efficiency of the stock used, the principles of application will be dealt with later, but the importance of taking out the average number of passengers and the average number of tons of freight carried in each train and in each loaded car or truck should be mentioned here. Most British Colonial Railways take out such figures, but the value of the information as an aid to operation would be much greater were the figures given separately for each section, for up and down traffic, and for traffic between specially important points on the system.

*Efficiency and utilisation of engines and rolling stock.*—As already mentioned, a material factor in economical working is to keep equipment employed on remunerative work. To maintain a check on this, records must be kept of the mileage run by engines and vehicles.

Particulars of the train-mileage actually run is kept by all railways; there is, however, no generally accepted classification of such mileage. Most administrations give separately

Passenger train-mileage;  
Goods train-mileage;  
Mixed train-mileage;

but it is desirable also to supplement this by giving the following particulars, at least, of the train service:

Other revenue train-mileage;  
Work train-mileage;

as well as particulars of other engine-mileage, viz.:

Assisting (banking, &c.), engines;  
Light engines;  
Shunting engines.

The latter should be calculated on some uniform basis per hour, preferably six miles, so as to be in accord with the practice in England, North America, and other countries.

The mileage run under each of the above classes, taken out regularly under sections, is of much use if any increases on the figures of previous periods are carefully scrutinised in conjunction with other figures, such as those of the average load per train and the average earnings per train-mile. Where these returns are supplemented by statements showing the percentages of each class to the total mileage run, any increase in the proportion of light mileage is at once brought into relief as a matter calling for enquiry. Again, the average mileage run under these heads by the engines in service during the particular period under review as compared with past periods, is a useful indication of whether the greatest possible work is being got out of the stock.

Some (but very few) administrations give also the average gross ton-mileage hauled per engine and a comparison with the maximum ton-mileage which could have been hauled by each type. Such assumed maximum ton-mileage is, of course, a figure based on ideal conditions, but affords a comparison more or less accurate between possible and actual efficiency.



Nearly all administrations keep for each locomotive a record of the mileage run by it each week or month throughout its running life. The information is of value in arriving at the rate of depreciation of engine stock.

*Vehicle-mileage and loads.*—The average vehicle-mileage run by passenger and goods stock is another figure of considerable value as indicating the extent to which the stock is being employed, while the average number of passengers per coach, or the average load per truck in the case of freight, gives information as to the efficiency of the loading, which is of the greatest possible value for comparative purposes. Where loads are substantially and habitually below the carrying capacity of the vehicles the returns will indicate a direction in which enquiry is called for.

Of course any such statistics lose part of their value unless they are taken out separately for sections of the line where the traffic conditions are exceptional; for instance, if one of the sections has very heavy mineral traffic carried in special trucks of large capacity, it is obviously desirable to isolate the figures for that particular section for special consideration.

A few administrations take out figures giving a comparison between the average loads of loaded cars under classes (as well as for all classes as a whole) and place against each class the average possible load. This gives a further general idea of the efficiency of the loading.

As the value of most statistics, and especially those relating to the actual working of traffic, largely depends upon the promptitude with which they can be made available, most railway systems apply quite a number of other checks on working long before some of the more elaborate returns referred to can be completed. In the early part of this paper, reference has been made to the special value of such "temporary" statistics to those entrusted with the operation and management of a railway system. The records of Colonial railways show that considerable attention and importance is attached to daily returns from stations, showing the loading of trains (both passenger and goods) and trucks, and the punctuality and average speed of trains; bad loading and delays in train service are promptly brought to notice and remedied, if possible, before they have time seriously to affect the results of working or give rise to public complaint, as the case may be.

Many uses and combinations\* of figures referred to above can be and are made by individual administrations, with which it is not possible to deal in a short paper, but a sufficiently clear idea of general methods and principles has been given, and I will now pass to the principles of such statistics as relate more closely to railway working expenditure and the staff employed and material used in operation.

#### (f) STATISTICS OF COST OF OPERATION.

In anticipation of that portion of the report which deals with the uniform classification of railway working expenditure, I have already referred to the importance of keeping expenditure records according to services rendered, rather than by departments and of subdividing such heads of expenditure according to proximity of services to the actual conveyance of traffic.

It is only when we come to the consideration of statistics of cost of operation and the principles on which they are based, that the full importance of a good arrangement of expenditure heads is fully demonstrated. Where such a classification exists, the operating officers can be readily supplied at very small cost with information as to the economy and efficiency, or otherwise, of general working. Without a proper classification, results are either obscured or have to be specially taken out, often at great expense.

With railway working expenditure, as with everything else, the larger the figures are the greater is the difficulty of grasping their significance. Where the only record is the total working expenditure month by month or year by

\* As instances the following may be mentioned; train-miles per engine hour; vehicle-miles per train-mile; ton-miles per vehicle mile.



year, comparisons as to the results achieved can only be made if one is satisfied that the conditions during the different periods were practically unchanged. Whether increases or decreases are shown as between one period and another, inquiry as to the causes which gave rise to them is naturally suggested. An increase (even with a decrease in the train-mileage run) does not necessarily imply bad working; it may have resulted in a large increase in the net surplus available, and be partially or wholly justified; it may be due to the operation of an increased mileage of lines, or to increased facilities being given in the matter of train services, to an increase in the volume of traffic handled, or to some necessary adjustment of rates of pay of the railway staff.

Similarly, a falling-off in the expenditure may be due to a reduction in the services rendered or to other causes, and may or may not be a matter for congratulation.

To make the position clear to the responsible officers of an administration it is essential, firstly, that the accounts should be in such a form as will be helpful and, secondly, that the "unit" or other statistics prepared should be appropriate and sufficiently complete to admit of correct deductions being arrived at without much trouble.

Whatever the heads of expenditure are, it is requisite that they should separate expenditure in connection with railway working from expenditure on services of a subsidiary or independent character. For the purpose of setting out the further development of statistics, it will be assumed that they distinguish clearly between expenditure for

- (1) Maintenance of way and works,
- (2) Maintenance of equipment (engines and rolling stock),
- (3) Transportation (*i.e.* running expenses),
- (4) Traffic,
- (5) General and other charges,

this being a division easy to follow and one to which quite a good number of the accounts kept by British Colonial railway administrations could, with very few alterations, be made to conform.

*Unit statistics of cost.*—The expenditure under each head, sub-head, and item is in most railways also reduced to "averages per unit," in the same manner as the earnings are worked out according to different units. The units used for expenditure are the same as those used for earnings; that is, the expenditure for each head may be shown:

- Per open-mile.
- Per mile of single track.
- Per train-mile.
- Per vehicle-mile.
- Per gross ton-mile.
- Per revenue ton-mile.
- Per passenger unit-mile.

The resulting figures are placed alongside the corresponding figures of earnings for the same units, and afford a general view (when compared with previous periods) of the results of operation.

So far as British Colonial railways are concerned, the most generally used unit for general comparisons is the "train mile."

Most administrations also show the percentage of each head of expenditure to

- (a) Earnings,
- (b) Total Expenditure,

a statement which is of considerable value to the administration in bringing to notice any radical variations in the proportions of the expenses for particular services at different periods.

*Statistics of staff employed.*—An instructive and useful general statement (compiled by several of the systems which have furnished information) shows for each separate branch of the railway service under specified grades the number of staff employed and their remuneration for the period covered, as well as similar information for previous periods for purposes of comparison. Any increases or decreases are also shown and the average number, average remuneration, and cost for each grade per open mile and per train-mile. Where comparisons are instituted with the figures of other administrations (which should be possible in the case of government railways or railways under the same control) such statements bring out the merits or demerits of any particular organisation, for in almost every administration by far the larger portion of the cost of working is represented by personal emoluments.

*Sectional figures of expenditure.*—Before passing on to statistics applying more particularly to the expenditure and working of individual departments or branches of the railway service, attention is drawn to the value of records showing separately the expenditure of the different branches or sections of a railway as a means of securing efficient and economical working. In quite a number of colonial railways (including the different systems in South Africa) such sectional records or statistics are regularly prepared. A specimen of the forms on which they are prepared on the Central South African Railways is reproduced\* in order to give an idea of what is meant. Blue prints of the completed forms are sent regularly to all the principal operating and other officials who have it in their power to influence expenditure. They are thus enabled to compare the working of one line with another—the lines for which they are responsible with those of their colleagues—and a spirit of friendly rivalry is induced which has been found in actual practice to result in large savings in expenditure. It will be seen that the expenditure for each section is given in totals and sub-totals as well as

per track-mile,  
per train-mile,  
percentage of earnings,  
percentage of total expenditure.

The amount regularly set aside for the renewals of capital assets of each section is shown separately in all cases, as the provision made for depreciation is a matter settled by the chief executive authority and is not controlled by the operating officials in any way.

In order to arrive at the working expenses on particular sections of the lines, certain items of expenditure common to several or all sections have of course to be *pro-rated* or distributed; it is not possible to formulate any general rules for such distribution which could be applied to railways generally. The cost of *Maintenance of Way and Works* can, as a rule, be accurately allocated to sections (any engineering superintendence being distributed as a percentage on the whole). That for *Maintenance of Locomotives*, including superintendence, can usually be apportioned between sections on the basis of the engine-mileage run on each. Similarly, the cost of *Maintenance of Passenger and Goods Vehicles* can be fairly apportioned according to the vehicle-mileage run on each section by passenger or goods vehicles.

*Transportation Running Expenses* can usually be charged to the actual sections in which the expenditure was incurred, and any balance distributed *pro rata* to the train-mileage run on the different sections. Expenses at large terminal stations sometime require special treatment and distribution over the sections benefited.

*Traffic Expenses (Stations, &c.)* are to a large extent capable of allocation to actual sections, and what remains can be fairly distributed on the basis of train-mileage.

\* See part 5.

*General and other charges* can as a rule be charged out to sections as a percentage on other expenditure.

Apart from the use of sectional figures as an aid to operation, they are often found useful when considering the claims of particular districts for increased facilities or additional lines. Notwithstanding the fact that they are based to some extent on averages, the writer believes that with care they can be made to reflect accurately the actual position and effect savings in working, out of all proportion to the cost of their preparation.

*Division of expenditure between "passenger" and "goods" services.*—It might be expected that, as they have largely followed English methods and practices, few railways in the British Colonies would take out separate figures of the cost of conducting the passenger and goods services and the cost per passenger per mile and per ton-mile, but this is not the case. Such figures are regularly taken out by most of the larger administrations and periodically by some of the smaller ones. Unfortunately, there is no uniform basis for arriving at such figures, which must depend for their accuracy on the degree of precision with which expenditure can be assigned to the passenger or goods services.

There can be little doubt that with the exercise of care in their preparation, separate statistics of the cost of hauling passengers and goods afford most valuable information to those directing the operation of a railway. Such figures should, in the opinion of the writer, be regarded as approximate only and as of value for administrative rather than for operating purposes; ton-mile costs for instance have and should have great value as one (but *only* as one) of the factors to be taken into consideration in fixing rates; for if they are reasonably accurate they afford a better measure of the value of the services rendered than any other unit. Even as regards operation, they give in one figure more complete information as to the average cost of transportation on particular lines or sections than can be obtained otherwise, and by long continued adherence to the same method of compilation, comparative figures of undoubted value are obtained since they represent in crystalised form practically all the elements of cost. The preparation of such statistics entails considerable expense, and the question whether the advantages obtained are such as to warrant such an expense is one which can be decided only by the administrations concerned.

*Ton-mile statistics.*—The whole question of the desirability of taking out ton-mile statistics is of a controversial character, and as it is impossible in this paper to discuss adequately the pros and cons thereof, I propose simply to offer some suggestions as to a method of apportioning expenditure between the passenger and goods services, in order to obtain the benefit of the criticisms of those present and, if possible, lay the foundations of some method which will be capable of general application.

All working expenditure incurred directly in connection with passenger or goods service to be allocated specially as either "passengers" or "goods," as the case may be. So far as expenditure is common to the two heads, the basis of division between "passengers" and "goods" to be as follows:

*Permanent Way and Works Maintenance* distributed pro rata to train-mileage of passenger and goods trains.

*Locomotive Maintenance* distributed pro rata to passenger train-mileage and goods train-mileage.

*Coaching Stock Maintenance* to be allocated to "passengers."

*Goods Stock Maintenance* to be allocated to "goods."

*Transportation (Running Expenses)* to be allocated to passengers and goods in proportion to mileage run by passenger and goods vehicles.

*Traffic Expenses* to be apportioned on basis of passenger and goods train-mileage.

*General Charges* to be apportioned as a percentage on total other expenditure.

In the case of administrations which are in the habit of taking out the gross ton-mileage hauled (*i.e.* the total ton-mileage including that of the vehicles containing the traffic) it is possible that the above suggestions may not be the best possible, but as against this it has to be borne in mind that comparatively few administrations do take out figures of gross ton-mileage, and what is sought is some general scheme which can be applied to most administrations without imposing on them the necessity of getting out additional statistics.

Attention is now directed to statistics specially relating to the working of individual branches of the railway service.

### MAINTENANCE OF WAY AND WORKS.

*Maintenance of way, works, and stations.*—Most administrations prepare statements showing under each head, sub-head, and item of expenditure the cost of maintenance “per mile of line maintained” giving comparisons with the figures for previous periods. As a rule, the mileage on which the costs are worked out is “route” or “point to point” mileage, but in many cases the figures are also given “per mile of single track including sidings”; the latter is the more satisfactory. The expenditure under each item is usually also given per train-mile and, in the case of administrations which are in the habit of taking out gross ton-mileage, per 1,000 gross ton-miles. The percentage of each of the different items to the total expenditure for Maintenance of Way and Works is also usually given.

All of these figures are useful; where it is not considered necessary to take out so much detail, it would seem to be advantageous to give information, at any rate, as to the costs

- (a) per mile of single track,
- (b) per total train-mile.

Statements showing by districts the cost of maintenance per mile of single track, under heads and sub-heads, and statements showing for each grade of the staff the average number employed (and the cost) per mile of single track for each section will be found, perhaps, as important for purposes of general control and comparison as any statements usually got out in connection with Maintenance of Way and Works.

So far as the permanent way itself is concerned, quite a number of other statistics are got out by different administrations with a view to ensuring that the capital assets of the administrations are maintained in good condition and that economies in working are not effected at the expense of capital account; amongst them may be mentioned the following which are regularly taken out by a number of railways amongst those furnishing their information for this paper:

*Ballast.*—Statistics of the number of cubic feet of different kinds of ballast put into the track, giving the cost per hundred cubic feet (by districts).

*Sleepers renewed.*—Statistics of the number of sleepers of different kinds taken out of the track and replaced, giving ages of the sleepers renewed (by district).

*Rails relaid.*—Statistics of the number of rails taken out of the track and replaced, giving weights of rails of different sections and values (by districts).

*Rails found broken.*—Statistics of broken rails discovered, giving mileage in each case and particulars and cause of break.

*Relaying.*—Particulars of cost of relaying work carried out in each district, showing separately expenditure for wages and material.

*Extraordinary expenditure for maintenance.*—Statements of special work entailed by slips and washaways (by districts).

*Bridges.*—Statistics of the cost of maintenance of each of the principal bridges in each district.



*Stations and buildings.*—Particulars of the cost of maintenance of each of the principal buildings on the system (by districts).

### **MAINTENANCE OF EQUIPMENT.**

Particulars of the statistics commonly prepared as to the maintenance of equipment by railways in the British colonies are given below.

#### ***Maintenance of Engines.***

Cost is usually worked out per train-mile and per engine-mile. (In many cases also the average cost of maintenance per 1,000 gross ton-miles is given.)

Statistics are also usually kept of the mileage run by each engine, month by month, and the actual cost for repairs of each engine.

*Note.*—If the cost of repairs is made to include running repairs (which unfortunately is not usually the case) it affords important information as to the relative expensiveness of maintenance of engines of different types.

Figures of the engine-mileage run by each engine are sometimes kept and are valuable in arriving at the proper provision to be made out of working expenses for replacement of particular types of engines.

As a check on working expenses and to ensure the maintenance of a proper standard, many British Colonial administrations prepare periodical statistics of the number of engines repaired and overhauled, giving particulars under classes of the repairs effected. The particulars of such repairs vary considerably for different administrations, but the following particulars are usually given :

Total passed through shops ;  
Built : new ;  
Re-erected ;  
Thoroughly overhauled ;  
Heavy repairs ;  
Light repairs ;  
Painted and varnished ;  
Touched up.

Special statistics of locomotive boilers repaired are usually kept

#### ***Passenger Vehicles : Maintenance.***

The expenditure for maintenance of passenger vehicles is usually reduced to statistics giving the average cost per passenger train-mile and per 1,000 passenger vehicle-miles. As in the case of locomotives, statistics are usually kept of the number of passenger vehicles of each class repaired and overhauled during the year, classifying the repairs under appropriate heads, giving for each the cost and the average cost per vehicle.

#### ***Goods Stock : Maintenance.***

Similar statistics to those kept in the case of passenger stock are usually prepared for goods vehicles. In order to get at the relative merits of different classes of trucks, much importance is usually attached to keeping separate records for the different types of trucks, especially where there is a great divergence in such types (as in the case of administrations carrying very heavy mineral traffic in specially designed and constructed trucks of large capacity).

### **TRANSPORTATION (RUNNING) EXPENSES.**

*Transportation : running expenses.*—Since running expenses usually constitute a large proportion of railway working expenditure, it is not surprising that voluminous statistics are kept by most administrations in connection with this particular service. The largest element in running expenses is usually



the remuneration of the drivers and firemen and other trained staff, and special statistics are, as a rule, prepared to show the cost per train-mile for such services, the number of staff engaged, the average mileage run per man—advantage being taken of such returns to compare the results achieved on different sections of the line. In addition to the detailed statistics showing the cost of running per train-mile and per engine-mile, many administrations secure an additional check by taking out the average cost per 1,000 gross ton-miles or per 1,000 vehicle-miles for the whole system as well as for districts. As a rule, regular comparisons are also periodically instituted between the numbers of the running staff, the average pay per man, and the average cost for each grade per train-mile and per engine-mile.

Another effective check on the expenditure for this service which appears to be fairly generally exercised is the compilation of statistics of the working of each engine shed on the system giving the shed costs in great detail, and the average cost per engine-mile, worked out on the mileage run by engines from each shed.

Most administrations agree in taking out in detail statistics of the coal consumption per train-mile and per engine-mile.

Where considerable expenditure is incurred for handling coal or pumping water, it is a common practice for administrations to take out, for each coal-ing and pumping station, the costs per ton and per 1,000 gallons, respectively. Comparisons between such stations are instituted thereafter for the purpose of bringing to light any excessive cost (where such exists) which may admit of reduction, either by the provision of more economical appliances or by the reduction of labour costs in other ways.

Oil consumption is usually worked out separately for engines and vehicles per engine-mile and per 1,000 vehicles-miles, respectively. Regular comparisons are also instituted with lubricating costs at other times and on other lines.

Reference has already been made in the early part of this paper to the importance of certain checks exercised with a view to ensuring the proper loading of trains and vehicles, and to the necessity of keeping a check on light engine and vehicle mileage.

A few administrations take out regularly for each type of engine, statistics of the actual work done (expressed in ton-miles) and the cost for each of the principal items making up running expenditure so as to afford a more accurate comparison of the relative efficiency of the different types in use. Such statistics are of an expensive nature to prepare and, as they are not generally compiled, it does not seem to be necessary to do more than observe that they have been found of considerable value by administrations whose operations are of such a magnitude as to warrant the expense of instituting such special inquiries. On smaller railway systems, operating officials are able to arrive at a judgment sufficiently accurate for all practical purposes without statistics of this nature.

### *TRAFFIC EXPENSES.*

*Traffic expenses.*—As a rule, traffic expenses are worked out per train-mile. In some cases, the expenditure on each item is shown as a percentage of the traffic earnings. As by far the greater portion of traffic expenses consists of the cost of stations and station staff, special statistics and returns are usually got out showing for each station the number of staff, their pay, and other expenses. Alongside these figures are usually placed particulars of the number of passengers bookings and the revenue and tonnage of goods traffic, in and out, so as to afford a ready comparison between station cost and station revenue. For the larger goods terminals, statements are taken out by many administrations in which the cost of handling, &c., are shown worked out on the tonnage of goods handled.

**GENERAL EXPENSES.**

*General and other charges.*—Most administrations prepare statements showing the cost of these services per train-mile, per cent. on total earnings, and per cent. of total expenditure.

Such general charges are, as a rule, more of the nature of fixed charges than other items of railway expenditure and vary less directly with increases or decreases in the traffic handled. It is necessary, therefore, to scrutinise each individual item separately, and there are few statistics which can with advantage be generally employed to effect comparisons between administrations. With regard to accounting work, however (which is usually embraced under the head of General Charges), certain comparisons have in the past been made between expenditure for this service by the different South African railway administrations on the basis of the cost of different sections of the work, expressed as a percentage of the revenue collected or the expenditure for railway service according to the nature of the work. To effect these comparisons, it is necessary to separate the cost of accounting for (a) earnings and (b) expenditure; such a division can, it is believed, be made with sufficient accuracy to afford a basis for instituting a very useful comparison, especially so far as the cost of accounting for railway expenditure is concerned.

**(g) STATISTICS RELATING TO INDIRECT AND SUBSIDIARY SERVICES.****INDIRECT SERVICES.**

By indirect services are meant the branches of the railway service which do not fall within the scope of any of those previously enumerated but exist for the benefit of the administration as a whole. The most important of these are the stores department and workshops.

*Stores department.*—As a rule, the service of maintaining an adequate supply of stores and material required in railway working is delegated to a special department whose duty it is to keep records under suitable heads of quantities and values of material in stock and any receipts and issues. Most of the returns furnished by the British Colonial railway administrations as to the classes and values of such stores are merely classified statements from the stock ledgers. Statistics showing the quantities and values of material handled at different stores depôts are, however, prepared by some administrations in which the stores expenses are stated as a percentage on the value of such receipts and issues. This information is an effective check if comparisons are given with earlier periods, and in those cases where expenditure of the stores department is charged out to other departments as a percentage on the value of the stores issued, the preparation of regular monthly or quarterly returns showing what the service is actually costing per cent., ensures that the distribution of the expenditure shall respond readily to any change in methods of working and cost.

*Workshops.*—The workshops of most railways are under the control of the locomotive department (or in cases of railways which have adopted American methods of organisation, the chief mechanical engineer). In some cases, there are separate workshops for the engineering and other departments, but modern practice seems to take rather in the direction of centralising work and having it done in the main workshops, *viz.*, under the control of the locomotive superintendent or the chief mechanical engineer, as the case may be. Whatever practice is adopted, the magnitude of the workshops expenditure of a railway administration is usually such as to necessitate the preparation of regular returns and statistics with a view either to effecting comparisons with the cost of getting the work done elsewhere, the cost on other railway administrations, or the cost of performing similar work during

some previous period. Broadly, the work done in the shops may be divided into two main classes :—

- (1) Work in connection with maintenance of equipment.
- (2) Manufacturing and other work done for other branches of the railway service or for the public.

Reference has already been made to the statistics usually prepared in regard to the maintenance of locomotives and passenger and goods stock. So far as manufacturing work is concerned, most administrations seem to rely on systems of cost accounting for an indication as to whether the work is being done economically or not. In the one or two cases where methods of cost accounting have been developed to a greater extent than is customary amongst railway administrations regular statistics are taken out of the cost of manufacturing particular articles or spare parts, thus admitting of comparisons being instituted between the cost of carrying out any particular class of work at different times. Apart from the value of such records as a check on economical working, statistics of this nature are found to be exceedingly useful as a guide in preparing estimates of the cost of carrying out any work and also in connection with the development of any system of remuneration by piece-work. Other statistics that have apparently been found of use in workshops control are statements of expenditure for each of the different shops, showing under separate items the charges for shop superintendence, chargemen, artisans, labourers, upkeep of machinery, power, light, heating, &c., and the percentage of such different items to the total expenditure of each shop. Where there is a foundry, or where an administration makes or rolls its own steel or carries on any separate industry of a similar nature, the ordinary commercial practice of taking out figures showing the output and the cost per ton or per other unit is usually followed with advantage. This observation may be regarded as applying also to the electric light and power branch of a railway where statistics are almost invariably taken out of the expenditure for generating and distribution per Board of Trade unit.

### *SUBSIDIARY SERVICES.*

Quite a number of railways perform services which are distinct from railway working although they are, as a rule, closely connected therewith. So far as the British Colonial railways are concerned, the most important of such subsidiary services are the cartage of traffic to and from stations, the provision of meals and hotel accommodation to passengers (in many cases to the general public also) and the running of steamship services in connection with the railways. Where such services are conducted, the statistics got out and the checks applied to expenditure are, as a rule, of a slightly different nature to those pertaining to the railway service proper.

The cost of cartage service is usually taken out under suitable heads for each station and statistics prepared showing cost per ton handled.

Catering and hotel services are usually reduced to such statistics as are kept by those engaged in the business of catering outside the railway service. A useful statement which has been furnished to me gives a comparison for different periods between the earnings, expenditure, net earnings, and percentage of profit at each of the station refreshment rooms, showing separately receipts and expenditure for meals and for alcoholic and other liquors, tobacco, cigars, cigarettes, &c. For dining-cars the earnings, expenditure, and net earnings for each car are shown separately and the average cost of meals served.

As regards statistics of steamship services, these usually follow the same general lines as are adopted by steamship companies.

## (h) OTHER MISCELLANEOUS STATISTICS.

*Staff: social condition.*—Apart from the statements showing the number and remuneration and average pay of staff in individual departments already referred to, it is quite usual on Government railways to furnish a considerable amount of information as to the condition of the staff. The value of such information is certainly great to the political economist, and it is occasionally useful to those directing the operation of a line. The following statements among others are prepared by some of the Colonial railways:

Statistics of social condition of staff showing nationality, age, whether married or single, average emoluments per day or per month or per annum for each grade, giving comparisons with previous years.

Statistics showing for each grade, the number of staff employed at the beginning of the period, appointments made during the period, wastage during the period (showing separately resignations, dismissals, services dispensed with, deaths, and transfers), total remaining at the end of the period.

(The figures of wastage worked out as a percentage on the staff employed will be found of interest and use in connection with staff arrangements, especially in a large administration where the staff is sufficiently numerous to allow of the operation of the law of average.)

Where pension and other institutions exist for the benefit of the staff, statistical information is usually compiled setting out the extent to which the privileges are availed of.

*Other social statistics.*—In practically all British Colonies, railways are required to render returns of accidents arising through the operation of railways. The form in which such returns are prepared varies almost with each Colonial Administration, but the best practice shows separately the number of:

- (a) Accidents to passengers;
- (b) Accidents to the general public other than passengers;
- (c) Railway employees.

For each class, the extent of the injuries sustained is shown, *e.g.*, a distinction is made between those killed and those injured. Further, the accidents are classified as far as possible according to their nature and causes.



### PART 3.

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#### Uniform Classification of Working Expenses.

Amongst English speaking nations and countries, there have been three successful attempts to introduce a classification of railway working expenses applying to all railways operating within the territory under which such classification has been promulgated. On each occasion, the classification has been one that has either been laid down or enforced by the Government.

The first uniform classification was that applied by Act of Parliament to English railways. This is generally admitted, even in England, to be inadequate and unsuitable, and at the present time, the question of its revision is engaging the attention of a Royal Commission, whose report will probably be available by the time the Congress meets in Berne.

The second was that applied by the Government of India to railways operating in the Indian Empire. This classification (though much more extensive) is in many respects marked by fairly close adherence to the English model.

The third is the comprehensive classification issued in the United States of America by the Inter-State Commerce Commission, and having the force of law. The last of these (as is fitting from the premier position of the United States in the matter of railway mileage) is in point of development far more complete than either the first or the second.

In considering what classification of working expenditure could be adopted for general use, one cannot fail to be influenced by the large amount of work which has been done at the instance of the Inter-State Commerce Commission in America, in settling the classification which now applies to all railways in the United States.

The principal differences between the American classification on the one side, and the English and Indian classifications on the other, are as follows:—

1. In America, there is a hard and fast line drawn between
  - (a) The operating expenses of railways and
  - (b) Expenditure in connection with subsidiary operations undertaken by railways.
2. In America, the cost of maintenance of locomotives and rolling stock is kept distinct from running expenses.
3. The cost of transportation is in America kept distinct from "traffic expenses."\*
4. In America, regular provision is made for charging working expenses with the estimated depreciation of the different classes of capital assets. Expenditure for replacement of such assets is met from depreciation funds, so far as it is covered by contributions standing to the credit of such funds, any balance being charged to working expenses;
5. The American classification not only sets out item by item clearly what shall be charged to working expenses, but also indicates clearly the classes and nature of expenditure which is to be charged to Capital and other Accounts.

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\* The term "Traffic expenses" is here used in the sense in which it is applied in America.



*Comparison of various classifications.*—The differences under the main heads of classification of expenditure in certain different countries are shown below :—

### Main Heads of Working Expenditure.

<i>United States of America (225,000 miles).</i>	<i>Great Britain. (24,000 miles).</i>	<i>British India. (29,000 miles).</i>	<i>Typical British Colonial Railway.</i>	<i>France (30,000 miles).</i>
Maintenance of way and structures.	Maintenance of way and works.	Maintenance of way, works and stations.	Maintenance of way, works and stations.	Maintenance of way and structures.
Maintenance of equipment.	Locomotive power.	Locomotive power.	Locomotive power.	Locomotive power and carriage and wagon expenses.
	Repairs and renewals of carriages and wagons.	Carriage and wagon expenses.	Carriage and wagon expenses.	
Traffic expenses.	Traffic expenses.	Traffic expenses.	Traffic expenses.	Traffic expenses
Transportation expenses.				
General expenses.	General charges.	General charges.	General charges.	General administration
	Rates and taxes.	Steamboat service.		
	Government duty.	Special and miscellaneous expenditure.		
	Compensation.			
	Legal and parliamentary expenses.			
	Miscellaneous.			
	Expenditure not allocated.			

From the above tabulated statement, it will be seen that the main heads in the American classification are intended to, and do, reflect the cost of the several main services connected with railway working, *viz.* :—

#### AMERICAN EXPENDITURE HEADS.

1. The maintenance of the track and its appurtenances and of the buildings utilised in connection with its operation.
2. The maintenance of the engines and rolling stock used for the conveyance of traffic ;

3. *Expenditure incurred in obtaining traffic and in affording information as to the facilities given by lines for the conveyance of traffic.*
4. *Expenditure directly or indirectly connected with the actual conveyance of traffic; such as cost of operation of trains and stations.*
5. General expenses.

As regards heads 1 and 5, these correspond to a large extent with heads in the classification adopted by most of the railways outside North America—that is to say Nos. 1 and 5 are at the present time practically uniform main heads of expenditure throughout the railway world.

In place of Nos. 2, 3 and 4 most railways outside North America record their expenditure under the following main heads:—

- (a) *Locomotive power.*—Includes maintenance of engines (American head 2) and running expenses of engines (American head 4).
- (b) *Carriage and wagon expenses.*—Includes maintenance of rolling stock (American head 2) and running expenses of rolling stock (American head 4).
- (c) *Traffic expenses.*—Includes cost of obtaining traffic (American head 3 and station and other staff (American head 4).

Uniformity of expenditure records could easily be obtained by the adoption of a classification comprising:—

1. Heads common to most administrations;
2. Separate heads for all items which are treated differently by (a) railways in North America and (b) other railways.

Such a classification would embrace the following heads:—

1. Maintenance of way, works, and structures.
2. Maintenance of equipment;
3. Transportation and traffic expenses.
  - (a) Running expenses and supplies (locomotives and vehicles).
  - (b) Station and other traffic staff.
  - (c) Cost of obtaining traffic, &c.
4. General charges.

[In the above list Nos. 3a and 3b together would correspond to the head "Transportation Expenses" in the United States classification, and Nos. 2a and 3a together would correspond with "Locomotive Power" and "Carriage and Wagon Expenses" in the other classification.]

The weak part of such a classification is that it is a compromise, and, like most compromises, it does not entirely satisfy the requirements of those accustomed to work to either of the classifications on which it is based. To the manager of an American line, it would seem a retrograde step were the present American classification altered so as to show separately the cost of departments which do not form part of the usual organisation of an American railway, but which exist in countries which have followed English practice, i.e., the locomotive department (which has control of the engine-drivers, firemen, and running shed staff) and the traffic department (which has charge of station staff, guards, &c.

On the other hand, the railway manager in other countries is accustomed to receive information as to the expenditure of each *department* of the organisation of which he has control, and any rearrangement of expenditure heads which decentralises, or appears to decentralise, the expenditure of a particular department, must have much to recommend it before securing his adherence.

So far as lucidity and arrangement go, the main heads of the American Expenditure Classification leave little to be desired, and the writer feels that no argument which he could put forward would detract from the superiority of that classification over any other that he has had the opportunity of

examining. Whether the general adoption of the American Classification in its entirety would be practicable at the present time or not is a matter worthy of discussion; if not, such a compromise as that suggested above appears to the writer the only alternative to losing the advantage of being able to institute comparisons with American systems.

Only the main heads (or grand divisions) of working expenditure have been dealt with above. For small railways it is quite conceivable that no more extended classification of working expenditure would be necessary than is comprised by the main heads under discussion, *viz.* :—

1. Maintenance of way, works, and structures;
2. Maintenance of equipment;
3. Transportation and traffic expenses;
4. General charges.

For larger systems, however, effective control would not be possible without some subdivision of such main heads. Such further analysis might with advantage be based on the actual subdivision of the work performed, since this remains practically the same whatever changes in organisation may take place.

In the annexures to this paper \* an attempt has been made to indicate for each main head of expenditure such sub-heads as appear generally suitable for adoption. In a third column, the process of subdivision is carried still further so as to cover the requirements of railways desirous of obtaining still more detailed information from their expenditure accounts. The classification outlined is composite, based principally on American practice with some slight alterations and additions based on South American (Buenos Ayres Great Southern), French, British, and British Colonial practice.

The proposals cover only the working expenditure of a railway, that is, the total cost of maintaining in good order and condition the capital assets of the railway and of carrying on the business of transportation, as distinct from the cost of performing other services (described in America as "Outside Operations") which are often performed by railways but equally often left to other agencies or put to tender.

#### *Treatment of Expenditure on "Indirect" Services.*

In connection with the matter of classification of working expenditure it is necessary specially to mention certain general services more or less directly connected with railway working such as the following :

Stores Department;  
General Workshops;  
Electric Light and Power Branch;  
Sanitation.

If the total cost of working a railway is to be recorded under certain main heads, it is submitted that all expenditure in connection with such subsidiary services as those set out above should be taken out separately and distributed on some well considered basis over the main expenditure heads themselves, having regard to the amount of work done for each. Unless there is uniformity in regard to the treatment of such expenditure it is apparent that no effective comparison is possible between one railway and another. Absolute uniformity in the expense classifications of these separate accounts is not essential at the present time, although desirable.

Similarly, it is desirable to keep separate records of such expenditure as that on

Fire and other insurance,  
Contributions to pension funds, sick funds, &c.,

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\* See part 5.

and to distribute the charges over the main heads of working expenditure if the total cost under each main head is to be arrived at.

### *Other Matters Affecting Working Expenditure.*

Other matters closely connected with the classification of expenditure arise out of the varying methods of providing for or accounting for

- (a) Maintenance, &c., of Staff Quarters, House Property, &c.;
- (b) Depreciation of Capital Assets;
- (c) Capital Expenditure and expenditure for Betterments.

In order to bring the question of the best method of treatment of such services under consideration, the following information is afforded as to the practice followed by the Central South African Railways—practice based largely on those obtaining on certain large lines in South America:

*Real estate.*—(a) Any profit (or loss) on “Real Estate Account” is carried to net revenue account. All revenue and expenditure in connection with quarters or other structures for which the administration receives or might receive rent is carried to a separate account called “Real Estate.” Such structures comprise:

- Quarters let to employees and others for which rent is paid by the occupier;
- Quarters let to employees and others for which rent is paid by the department;
- Buildings occupied by the cartage department;
- Buildings occupied by the catering department.

The revenue includes all rents and receipts for water, sanitary and other services. (Where quarters are occupied by employees rent free, the amount of the rent is charged to the departments to which the employees belong.) The Expenditure includes cost of maintenance, water supply, sanitation, rates and taxes, fire insurance, depreciation, &c.

*Depreciation of capital assets.*—(b) Provision is made for charging working expenditure with amounts for depreciation and crediting such amounts to renewals or replacement funds until such time as it becomes necessary to renew the different assets. The following example will serve to explain the working of the different depreciation funds:

A locomotive is purchased at a cost of £5,000 on the opening of the railway, and is placed in traffic on January 1, 1908. Its life is estimated at 20 years. Each year (in addition to the cost of *all* repairs) one-twentieth of its original cost is charged to working expenses under Locomotive Maintenance (depreciation) and credited to “Locomotive Renewals Fund.” By December, 31, 1927, this fund will show a credit balance of twenty times £250 = £5,000. The original locomotive is now worn out, its scrap value being say, £300. It is desired to purchase a new locomotive in place of the old one, and the following adjustment is made in the book:—

An asset worth £5,000 has disappeared, so Capital Account is credited with £5,000 and Renewals Fund debited with that amount.

On the purchase of a new locomotive, say, for £6,000, Capital Account is debited with cost.

As regards the scrap value of the old locomotive, it is considered desirable for the present to credit Renewals Fund with the amount realised (less any cost of breaking up or of sale); this amounts in fact to an additional contribution for depreciation.



In case the locomotive were scrapped at the end of 10 years (*i.e.*, 10 years before its estimated life expired) working expenditure would still be charged with depreciation on the engine for the remaining 10 years. If, on the other hand, it lasted 50 years (*i.e.*, 30 years beyond its assumed life), no depreciation would be charged on it during the last 30 years.

All assets of the railway (and of subsidiary departments) which are liable to depreciation are treated in the same way, the percentage set aside for depreciation being based on the estimated life. All money for replacements is provided by transfers from the different "Renewal Funds."

[It will be apparent that uniformity with regard to the matter of depreciation must be attained before effective comparisons can be made between two or more railway systems. At present, some administrations rely upon replacing out of current working expenditure capital assets which are no longer serviceable, and as a rule, no distinction is made in their accounts between ordinary working expenditure and expenditure for such replacements. In addition to rendering impossible any comparisons with working results of other railways which meet such special expenditure from renewals funds, such a practice seriously disturbs comparisons on the same railway between the working expenditure of a year when little renewal work has been undertaken, and a year when much of it has had to be done. This it is contended is fair neither to the administration nor to the investor who has provided the capital required for railway purposes.]

*Capital expenditure and expenditure for betterment.*—(c) Expenditure for the acquisition of entirely new assets is on the Central South African Railways charged to capital account, and also expenditure for improvements or additions tending to increase earnings or reduce working expenses. Separate records are kept of the capital expenditure of

(a) The railway proper.

(b) Real Estate Department (dwelling-houses, &c.)

(c) Workshops' machinery and equipment.

(d) Cartage Department. } (These Departments have separate

(e) Catering Department. } Capital Accounts of their own.)

(In the case of the last four items all expenditure for improvements or additions is charged to capital account except in cases where the amount is trivial when it is charged to working expenses.)

In the case of the railway proper, expenditure for improvements and additions is charged to:—

Working expenses... If the amount does not exceed £50.

Betterment Fund ... If the improvement does not mean the acquisition of entirely new assets or increase earnings or reduce working expenses.

[The importance of securing uniformity in regard to the treatment of expenditure on improvements is so inseparably bound up with the question under consideration that this paper would not be complete were attention not drawn to the fact that there is at present considerable diversity of practice amongst British Colonial railways in regard to the matter.]



## PART 4.

## Conclusions of Reporter.

## PRINCIPLES OF STATISTICS OF RAILWAYS IN OPERATION.

The majority of the statistics usually prepared on British Colonial railways fall under one of two classes :—

1. Those statements or returns (including approximate returns) which are available at a sufficiently early date to serve as an effective aid to operating officers and to the supreme executive head of an administration.
2. Those more permanent records which usually require longer time for preparation and are sometimes of less value for the direction of current operative details than for the purpose of bringing under scrutiny the general results attained as well as the tendencies and influences which the figures indicate so as to serve as a guide to the administration in matters of general policy and finance.

The real test of the worth of statistics of either class in their utility. Money spent in the preparation of statistics which have no value for operating purposes or for purposes of guidance in matters of policy, is money wasted.

In the case of the British Colonial railways, the statistical data taken out varies (as is natural) with local conditions and requirements, and the principle of utility seems to be everywhere well recognised.

In the opinion of the reporter, the statistical data of a more permanent nature would have much greater value if uniformity were secured in the railway methods of accounting and if an agreement were come to by all railways—parties to this congress—with regard to such matters at the method of calculating open mileage, train-mileage, vehicle-mileage, ton-mileage, and other units used in the preparation of statistics.

The standardising at any rate of the principal statistical returns and the establishment of a recognised standard classification of statistical data, on lines approved by this conference, which would be suitable for general adoption, would also add considerably to the value of the statistics of individual railways, since it would enable any one administration to compare results with any other to the advantage of all concerned.

## UNIFORM CLASSIFICATION OF RAILWAY WORKING EXPENSES.

There is no uniformity in the classification of working expenditure of railways in the British Colonies, although there is a classification common to all the railways in British India.

Generally the classification of such expenditure follows the English model, with such additions and modifications as appear necessary to meet local conditions, but the differences in accounting methods and in the heads of the classification are together so pronounced as to render comparisons between one railway and another either misleading or impossible.

The acceptance of some standard classification of railway working expenditure and of an agreement as to the treatment of expenditure for

- (a) replacements of capital assets,
- (b) improvements of capital assets,
- (c) capital purposes,
- (d) subsidiary services in connection with railways (such as catering),

would be of inestimable advantage not only to railways in British Colonies but to railways throughout the world generally.

## ANNEXURE No. 3 (SPECIMEN 1).

## VICTORIA GOVERNMENT RAILWAYS.

Statement showing the total cost (exclusive of Rolling Stock), length, highest point, steepest gradient, and average cost per mile of each line; also the cost of Rolling Stock, Workshops, General Offices, &c., at June 30, 1907.

Lines.	Length of lines opened for Traffic.			Height of Rail-level above low water mark.			Steepest gradient.			Cost, exclusive of rolling stock, general offices, workshops, &c.		
	Double and over.	Single.	Total.	Highest.	Lowest.					Total.	Average per mile.	
	Miles.	Miles.	Miles.	Ft.	Ft.	Ft.				£	s. d.	£
Melbourne to Bendigo exclusive of works, Melbourne to Essendon Junction ...	100·89	...	100·89	1,902	18	1	in			4,826,166	7 9	47,836
(Here follow other sections of lines.)							£0					
Total mileage open for traffic at June 30, 1907 ... ..	311·26	3,089·81	3,401·07	...	...	...				...		...
Works, Melbourne to Essendon Junction	...	...	...	...	...	...				1,603,846	17 5	...
Railway offices, Spencer Street ... ..	...	...	...	...	...	...				161,332	16 6	...
Sheds and workshops, Williamstown ...	...	...	...	...	...	...				154,054	10 9	...
Sheds and workshops, Newport ... ..	...	...	...	...	...	...				371,294	10 9	...
General Construction account (capital expenditure common to all lines) ..	...	...	...	...	...	...				372,127	10 11	...
Rolling stock (broad gauge) ... ..	...	...	...	...	...	...				6,049,415	18 6	...
Rolling stock (narrow gauge) ... ..	...	...	...	...	...	...				38,280	10 5	...
Rolling stock, electric street railway ...	...	...	...	...	...	...				14,304	8 3	...
Grand total ...	311·26	3,089·81	3,407·01	...	...	...				41,251,976	6 10	...

## ANNEXURE No. 3 (SPECIMEN 2).

## CENTRAL SOUTH AFRICAN RAILWAYS.

Statement showing Engines owned at December 31, 1908.

Description.	Stock at December 31, 1907.	During 1908.		Stock at December 31, 1908.	Average tractive force.	Average cost.	Date placed in traffic.	Condition.			
		Additions.	Reductions.					Good.	Fair.	Poor.	Obsolete.
14-ton Z.A.S.M. ... ..	2	..	..	2	lbs. ...	£ 1,715	1889	1	1	..	..
(Here follow similar particulars for all classes of locomotives.)											

(SPECIMEN 3.)

Statement showing tonnage of Traffic, grouped according to distance, carried over Home Lines, 1908-1907.

*Local traffic.*

Rate.	Commodity.	1 to 10 miles.		11 to 25 miles.		(Similar information for— 26 to 50 miles 51 „ 100 „ 101 „ 150 „ 151 „ 200 „ 201 „ 300 „ &c., &c.).
		1908.	1907.	1908.	1907.	
First class...	Wines and spirits					
	Tobacco and cigars					
	Other first-class ..					
	Total first-class					
(Similar information for other classes.)						

## ANNEXURE NO. 3 (SPECIMEN 4).

Central South African Railways—*continued*.

Statement showing the tonnage of principal classes of traffic forwarded from the Coast Ports to the competitive zone, 1904 to 1908.

*Tonnage.*

From.	First-class traffic.					
	1904.	1905.	1906.	1907.	1908.	
Cape ports—						
Cape Town and Table Bay Docks ... ..	2,402	3,166	2,123	1,646	2,019	(Similar information for other classes of traffic.)
Port Elizabeth and Algoa Bay	12,979	15,767	14,468	13,164	13,795	
East London and Buffalo Harbour ... ..	3,613	3,853	2,533	2,145	2,525	
Total Cape Ports ...	18,994	22,786	19,124	16,955	18,339	
Durban, Point, and Berea Road ... ..	27,931	32,140	23,262	15,384	14,467	
Delagoa Bay ... ..	5,398	5,964	5,490	4,765	6,115	
Total ... ..	52,323	60,890	47,876	37,104	38,921	

*Percentage of tonnage.*

From.	First-class traffic.					
	1904.	1905.	1906.	1907.	1908.	
Cape Ports—						
Cape Town and Table Bay Docks ... ..	4·6	5·2	4·4	4·4	5·2	(Similar information for other classes of traffic.)
Port Elizabeth and Algoa Bay ... ..	24·8	25·9	30·2	35·5	35·4	
East London and Buffalo Harbour ... ..	6·9	6·3	5·3	5·8	6·5	
Total Cape Ports ...	36·3	37·4	39·9	45·7	47·1	
Durban, Point, and Berea Road ... ..	53·4	52·8	48·6	41·5	37·2	
Delagoa Bay .. ..	10·3	9·8	11·5	12·8	15·7	
Total ... ..	100·0	100·0	100·0	100·0	100·0	

## ANNEXURE No. 3 (SPECIMEN 5).

## INDIAN RAILWAYS.

Analysis of Working, half-year ended December 31, 1907.

Progressive number.	Headings.	Six months ended December 31, 1907.	Corresponding period previous year.
No. I.			
DESCRIPTION OF RAILWAY WORKED.			
1	Gauge of railway ... ..	—	
2	Mean mileage worked ... ..	miles.	
3	Number of stations .. ...	No.	
4	Total length of the following gradients—		
	(a) 1 in 50 and less ... ..	miles.	
	(b) 1 in 51 to 1 in 80 ... ..	—	
	(c) 1 in 81 to 1 in 100 ... ..	—	
	(d) 1 in 101 to 1 in 200... ..	—	
	(e) 1 in 201 to 1 in 300 ... ..	—	
5	Steepest gradient worked .. ...		
No. II.			
FINANCIAL RESULTS.			
6	Percentage of net earnings (including steamboat traffic) on capital outlay ... ..	per cent.	
7	Percentage of net earnings on paid-up capital ... ..	—	
No. III.			
OUTLAY, EARNINGS AND EXPENSES.			
(Exclusive of Steamboat Service).			
8	Capital outlay per mile open ... ..	rupees.	
9	Total earnings per mile open per week ... ..		
10	Total working expenses per mile per week ... ..	—	
11	Total earnings per train-mile ... ..	—	
12	Total working expenses per train-mile ... ..	—	
13	Net earnings per train-mile ... ..	—	
14	Cost per 1,000 gross ton-miles moved (freight and deadweight) ... ..	—	
15	Percentage of total working expenses upon total earnings ... ..	per cent.	
16	Percentage of total working expenses upon total earnings, excluding from both sides of the account the charges for carriage of revenue stores ... ..	—	
(Inclusive of Steamboat Service.)			
17	Percentage of total working expenses on total earnings (for details, see Table No. VII) ... ..	—	



Annexure No. 3 (Specimen 5—*continued*).Analysis of Working, half-year ended December 31, 1907—(*continued*).

Progressive number.	Headings.	Six months ended December 31, 1907.	Corresponding period previous year.
	<i>No. IV.</i>		
	DIVISION OF EXPENDITURE BETWEEN COACHING AND GOODS TRAFFIC.		
18	Total working expenses for both coaching and goods traffic, excluding steamboat expenses, and after deducting telegraph and sundry receipts and leaving only the balance of payments to other lines for mileage, &c. ... .. rupees.		
	Proportions, <i>dividing expenditure in ratio of gross ton-mileage (freight and dead load).</i> ... ..		
19	Coaching... .. —		
20	Goods ... .. —		
	<i>No. V.</i>		
	COACHING TRAFFIC.		
	<i>Gross Receipts and Mileage.</i>		
21	Receipts from coaching traffic ... .. rupees.		
22	Coaching train-miles run ... .. No.		
23	Average coaching receipts per train-mile ... .. rupees.		
	<i>Units and Unit-mileage.</i>		
	Number of units carried one mile—		
24	First class ... .. unit-miles.		
25	Second class ... .. —		
26	Third, or intermediate class ... .. —		
27	Fourth, or lowest class ... .. —		
28	Total passenger unit-mileage ... .. —		
29	Other coaching traffic ... .. ton-miles.		
	Average sum received for carrying a unit one mile—		
30	First class ... .. pies.		
31	Second class... .. —		
32	Third, or intermediate class ... .. —		
33	Fourth, or lowest class ... .. —		
34	Average for all classes ... .. —		
35	Other coaching traffic per ton-mile ... .. —		
	Average number of units in a train—		
36	First class ... .. No.		
37	Second class... .. —		
38	Third, or intermediate class ... .. —		
39	Fourth, or lowest class ... .. —		
40	Total passenger units ... .. —		
41	Other coaching traffic ... .. tons.		

Annexure No. 3 (Specimen 5)—*continued.*Analysis of Working, half-year ended December 31, 1907—(*continued.*)

Progressive number.	Headings.	Six months ended December 31, 1907.	Corresponding period previous year.
<i>Vehicles and Vehicle-mileage.</i>			
	Number of coaching vehicles hauled one mile—		vehicle-miles.
42	First class ... ..		—
43	Second class... ..		—
44	Third, or intermediate class ...		—
45	Fourth, or lowest class ... ..		—
46	Other vehicles ... ..		—
47	Brake vans ... ..		—
48	Total ... ..		—
	Average number of vehicles in a coaching train :—		No.
49	1st class ... ..		—
50	2nd class ... ..		—
51	3rd or intermediate class ... ..		—
52	4th or lowest class ... ..		—
53	Other vehicles ... ..		—
54	Brake vans... ..		—
55	Total... ..		—
	Average earnings per coaching vehicle per mile :—		pies.
56	1st class ... ..		—
57	2nd class ... ..		—
58	3rd or intermediate class ... ..		—
59	4th or lowest class ... ..		—
60	Other vehicles ... ..		—
	Carrying capacity hauled one mile (excluding brakes) :—		tons.
61	1st class ... ..		—
62	2nd class ... ..		—
63	3rd or intermediate class ... ..		—
64	4th or lowest class ... ..		—
65	Other vehicles ... ..		—
	Percentage of freight on capacity hauled :—		per cent.
66	1st class ... ..		—
67	2nd class ... ..		—
68	3rd or intermediate class ... ..		—
69	4th or lowest class ... ..		—
70	Other vehicles ... ..		—
<i>Working of train and ton-mileage.</i>			
	Gross ton-mileage of all coaching trains :—		ton-miles.
71	Freight ... ..		—
72	Dead weight ... ..		—
73	Total ... ..		—
	Average weight of a coaching train :—		—
74	Freight ... ..		—
75	Dead weight ... ..		—
76	Total... ..		—

NOTE.—The passenger unit mileage is based on the shortest route, and the train and vehicle-mileage on the actual route.

Annexure No. 3 (Specimen 5)—*continued.*Analysis of Working, half-year ended December 31, 1907—(*continued.*)

Progressive number.	Headings.	Six months ended December 31, 1907.	Corresponding period previous year.
<i>Cost of working and profits.</i>			
77	Average cost of hauling a coaching train one mile ... ..	rupees.	
78	Average cost of hauling a coaching vehicle with its load one mile ...	pies.	
	Average cost of hauling a coaching unit one mile :—		
79	Per passenger unit ... ..	pies.	
80	Other traffic per ton ... ..	—	
81	Average profit on working a coaching train one mile ... ..	rupees.	
	Average profit on working a coaching vehicle one mile :—		
82	1st class ... ..	pies.	
83	2nd class ... ..	—	
84	3rd or intermediate class ... ..	—	
85	4th or lowest class ... ..	—	
86	Other vehicles ... ..	—	
	Average profit on working a coaching unit one mile :—		
87	Per passenger unit ... ..	pies.	
88	Other traffic per ton ... ..	—	
<i>No. VI.</i>			
<i>GOODS TRAFFIC.</i>			
<i>Gross receipts and train-mileage.</i>			
89	Receipts from goods traffic ... ..	rupees.	
90	Goods train-miles run ... ..	No.	
91	Average goods receipts per train-mile ... ..	rupees.	
<i>Units and unit-mileage.</i>			
92	Tons of goods carried one mile ...	ton-miles.	
93	Average sum received for carrying a ton one mile ... ..	pies.	
94	Average number of tons in a train	tons.	
<i>Vehicles and vehicle-mileage.</i>			
	Number of goods vehicles hauled one mile :—	vehicle-miles.	
95	Loaded ... ..	—	
96	Empty ... ..	—	
97	Brake-vans... ..	—	
98	Total ... ..	—	
	Average number of vehicles on a goods train.—		
99	Freight vehicles ... ..	No.	
100	Brake-vans... ..	—	
101	Total... ..	—	

NOTE.—The ton-mileage is based on the shortest route, and the train and vehicle-mileage on the actual route.

Annexure No. 3 (Specimen 5)—*continued.*Analysis of Working, half-year ended December 31, 1907—(*continued*).

Progressive number.	Headings.	Six months ended December 31, 1907.	Corresponding period previous year.
<i>Vehicles and vehicle-mileage (continued).</i>			
102	Average earnings per goods vehicle per mile (excluding brakes) ...	pies.	
103	Carrying capacity hauled one mile (excluding brakes) ...	tons.	
104	Percentage of freight on capacity hauled ...	per cent.	
105	Average load of a goods vehicle (including both loaded and empty) ...	tons.	
106	Average load of a loaded goods vehicle ...	—	
<i>Weight of train and ton-mileage.</i>			
Gross ton-mileage of all goods trains:—			
107	Freight ...	tons.	
108	Dead weight ...	—	
109	Total ...	—	
Average weight of goods trains:—			
110	Freight ...	tons.	
111	Dead weight ...	—	
112	Total... ...	—	
<i>Cost of working and Profit.</i>			
113	Average cost of hauling a goods train one mile ...	rupees.	
114	Average cost of hauling a goods vehicle with its load one mile ...	pies.	
115	Average cost of hauling a goods unit (viz., one ton) one mile ...	—	
115A	Average cost of hauling a goods unit one mile, including interest on capital expenditure on open line at the rate of 5 per cent. per annum... ..	—	
116	Average profit on working a goods train one mile ...	rupees.	
117	Average profit on working a goods vehicle with its load one mile ...	pies.	
118	Average profit on working goods unit (viz., one ton) one mile ...	—	

## ANNEXURE No. 3 (SPECIMEN 6).

## SOUTH AUSTRALIA.

Summary of the results of maintenance on each system of lines in comparison with those of the last three years.

Name of system and gauge.	Year.	Miles of single line.	Miles of sidings.	Ordinary and current repairs.		Extraordinary repairs and renewals.		Average number of men employed per mile, including sidings.					
				Cost per mile of single line, sidings included.	Cost per mile of single line, sidings not included.	Cost per mile of single line, sidings included.	Cost per mile of single line, sidings not included.	Superintendence.	Artisans.	Gangers.	Packers.	Labourers.	Total.
5 ft. 3 in.	{ 1905	M. C. 247 74	M. C. 70 78	£ s. d. 106 16 2	£ s. d. 113 3 1	£ s. d. 14 8 10	£ s. d. 18 11 6	0·03	0·13	0·10	0·31	0·17	0·74
				113 3 1	145 10 11	35 6 2	45 8 4	0·03	0·11	0·11	0·31	0·22	0·78
	{ 1907	247 74	70 78	108 10 4	139 9 6	224 16 3	289 3 5	0·03	0·32	0·10	0·31	0·99	1·75
				127 6 4	163 15 3	248 15 11	320 0 5	0·03	0·37	0·11	0·30	1·09	1·90
Port and North ...	{ 1908	247 74	70 78										

(Similar information for each section.)



## ANNEXURE No. 3 (SPECIMEN 7).

## WESTERN AUSTRALIAN GOVERNMENT RAILWAYS.

Cost of working the principal classes of locomotives for 1905, 1906, 1907 and 1908.

Class.	Where built.	Date placed on traffic.	Average engine mileage per engine for four weeks.				Average cost per engine-mile.				Average cost per engine-mile per 100 tons hauling power.				Where running.
			1908	1907	1906	1905	1908	1907	1906	1905	1908	1907	1906	1905	
C	America	1902	1,187	1,952	1,683	1,793	184	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	Pence.	—
			2,326	1,756	2,123	1,937	108	16·23	10·70	13·81	11·47	8·82	7·50	6·23	
T	Great Britain	1889						7·25	10·71	7·81	9·33	6·71	7·23	8·63	—

\* Ruling gradients on main lines :—

Eastern	...	...	...	1 in 45	Eastern Goldfields	...	1 in 60
Great Southern	...	...	...	1 in 55	South-Western	...	1 in 75
Collie	...	...	...	1 in 40	Donnybrook-Bridgetown	...	1 in 40
Northern	...	...	...	...	...	...	1 in 50

# NEW ZEALAND GOVERNMENT RAILWAYS.

Locomotive Returns for the Year ended March 31, 1908.

Section on which employed.	Type.	Number of Engines.		Average Speed : Miles per hour.				Engine Mileage.			Quantity of Stores.				Cost.				Cost per Engine-mile in pence.				Days in Steam.	
		Train.	Shunting and Empty.	Work Train.	Total.	Coal.	Oil.	Tallow.	Waste.	Re-pairs.	Running.			Re-pairs.	Running.			Wages and Material.	Stores.	Fuel.	Wages.	Total.		
											Detail.													
Kawakawa Section	{ C	1	15	3,720	1,279	422	5,421			933	158	12	75	£ 18	7	71	162	£ 258	0·80	0·31	3·14	7·17	11·42	104
		1	15	3,264	1,170	116	4,550			873	138	6	72	32	6	67	138	243	1·69	0·32	3·53	7·28	12·82	94
	Totals	2	—	6,984	2,449	538	9,971			1,806	296	18	147	50	13	138	300	501	1·20	0·31	3·32	7·22	12·05	198
		General charges		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	54	—	—	—	—	1·30
	Totals		—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

(Similar data for each Section.)

## ANNEXURE No. 3 (SPECIMEN 9).

## NEW SOUTH WALES GOVERNMENT RAILWAYS.

Comparative Statement showing for Week ending ..... 1907, number of men employed and cost per Engine-mile for Driving, Firing and Cleaning in each District.

D., F., C. represent Drivers, Firemen and Cleaners respectively.

S. II. (shed hands) embraces Engine Turners, Tube Cleaners, Washers-out, Firelighters and Gland Packers.

District.	1907.				1906.				Increase or decrease in 1907.	
	Number of Men.		Average rate per day.		Amount of wages and expenses.		Engine-mileage.	Cost per mile driving, firing and cleaning.	Total cost per mile for all services.	Similar figures for corresponding week in previous year.
	Classified.	Acting.	Total.	Actual service driving, firing and cleaning.	Holidays and sick pay.	Other services.				
				£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.		
D.	222	39	261	2,161 5 3	92 14 0	9 4 11	2,263 4 2	2 725 2 737	0 021	—
F.	225	77	263	1,527 0 2	62 10 6	—	1,589 10 8	1 922 1 922	—	0 025
C.	158	38	119	451 10 9	11 3 0	35 1 11	497 15 8	0 559 0 601	—	0 194
S. II.	—	—	—	—	—	—	178 18 2	—	0 009	—
	605	38	643	4,139 16 2	166 7 6	44 6 10	4,529 8 8	5 206 5 478	—	0 189
							198,543	5 206 5 478	—	309
										275

(Similar information for each district.)

## ANNEXURE No. 3 (SPECIMEN 10).

## CENTRAL SOUTH AFRICAN RAILWAYS.

Sectional Statistics.—Showing Expenses per unit under each head of Estimates.

Month of \_\_\_\_\_ 190 .

ORDINARY WORKING EXPENDITURE, i.e., EXCLUSIVE OF RENEWALS.															
Section.	Capital Cost (Approximate).	Open Track-mileage.	Train-mileage.	Earnings per Train-mile.	(a) Per Train-mile.							(b) Per cent. of total expenditure.	(c) Per cent. of earnings.	(d) Per track-mile.	Under same heads.
					Transportation.		Maintenance of Equipment.	Maintenance of Way, Works, and Telegraphs.	Other Expenditure, (General Charges and Misc.)	Total.					
					Traffic.	Locomotive Running.									
(Continued.)															
TOTAL EXPENDITURE.															
Working.					Total.		This year.					Last year.			
Transportation.		Maintenance of Equipment.	Maintenance of Way, Works, and Telegraphs.	Other Expenditure (General Charges and Misc.)	Renewals.	Amount.	Per cent. of Earnings.	Total Earnings.	Profit.	Loss.	Profit.	Loss.			
Traffic.	Locomotive Running.														

Note.—The same information is also shown month by month on a separate statement for each section.

## ANNEXURE NO. 5.

## Draft Scheme for Uniform Classification of Working Expenses.

Main heads (for small railway systems).	Heads for larger railways.	Heads for largest systems.
1.—Maintenance of way, works and structures.	1.—Maintenance of way, works and structures.	I.—Maintenance of way, works, and structures.
1. Superintendence.	1. Superintendence.	1. Superintendence. <ul style="list-style-type: none"> <li>a. Engineers and other professional staff: salaries and wages.</li> <li>b. Office staff: salaries and wages.</li> <li>c. Other staff: salaries and wages.</li> <li>d. Office and miscellaneous expenditure.</li> </ul>
2. Permanent way: Maintenance.	2. Permanent way: Maintenance. <ul style="list-style-type: none"> <li>a. Salaries and wages.</li> <li>b. Materials and other expenses.</li> </ul>	2. Permanent way: maintenance. <ul style="list-style-type: none"> <li>a. Salaries and wages.</li> <li>b. Materials: <ul style="list-style-type: none"> <li>1. Ballast.</li> <li>2. Sleepers.</li> <li>3. Rails.</li> <li>4. Other track materials.</li> </ul> </li> <li>c. Other expenses.</li> </ul>
3. Track structures: Maintenance.	3. Track structures: Maintenance. <ul style="list-style-type: none"> <li>a. Salaries and wages.</li> <li>b. Materials and other expenses.</li> </ul>	3. Track structures: Maintenance. <ul style="list-style-type: none"> <li>a. Tunnels.</li> <li>b. Bridges.</li> <li>c. Crossings, fences, cattle guards and signs.</li> <li>d. Signals and interlocking plant.</li> <li>e. Telegraphs and telephones.</li> <li>f. Electric power and transmission.</li> <li>g. Water supply.</li> </ul> <p>(Further subdivisions may be effected under "Wages" and "Material" if necessary.)</p>
4. Buildings and grounds: Maintenance.	4. Buildings and grounds: Maintenance. <ul style="list-style-type: none"> <li>a. Salaries and wages.</li> <li>b. Materials and other expenses.</li> </ul>	4. Buildings and grounds: Maintenance. <ul style="list-style-type: none"> <li>a. Stations and station grounds.</li> <li>b. Other buildings (excluding dwelling houses, workshops, and stores buildings.</li> </ul>
5. Miscellaneous expenses.	5. Miscellaneous expenses.	5. Miscellaneous expenses. <ul style="list-style-type: none"> <li>a. Insurance.</li> <li>b. Injuries to persons.</li> <li>c. Stores expenses.</li> <li>d. Other expenses.</li> </ul>





Annexure No. 5—*continued*.Draft Scheme for Uniform Classification of Working Expenses—*contd.*

Main heads (for small railway systems).	Heads for larger railways.	Heads for largest systems.
II.—Maintenance of equipment ( <i>continued</i> ).	II.—Maintenance of equipment ( <i>continued</i> ). <i>c. Goods :—</i> 1. Maintenance. 2. Depreciation.	II.—Maintenance of equipment ( <i>continued</i> ). <i>c. Goods stock : mainten-</i> <i>ance.</i> 1. Wages. 2. Material. 3. Indirect expenses, viz. :— Superintendence. Wages. Material. Use of machinery and power. Other expenses. 4. Depreciation fund contributions.
III. — Transportation and Traffic Expenses.	III. — Transportation and Traffic Expenses. <i>a. Running expenses and supplies.</i>	III.—Transportation and traffic expenses. <i>a. Running expenses and supplies :—</i> 1. Superintendence. 2. Drivers (wages). 3. Firemen (wages). 4. Guards and conductors (wages). 5. Running shed staff (wages). 6. Other Staff. 7. Fuel :— Labour. Coal and wood. Plant : maintenance. Other expenses. 8. Water :— Labour. Water purchased. Plant : maintenance. Other expenses. 9. Lubricants. 10. Running stores and supplies. 11. Coaches :— Lighting. Cleaning. 12. Wagons :— Cleaning and disinfecting. Tarpaulins : maintenance. 13. Other expenses.

Annexure No. 5—*continued*.Draft Scheme for Uniform Classification of Working Expenses—*contd.*

Main heads (for small railway systems).	Heads for larger railways.	Heads for largest systems.
	<p>III.—Transportation and traffic expenses (<i>continued</i>).</p> <p>b. Station and other traffic expenses.</p> <p>c. Advertising and canvassing.</p> <p>d. Compensation.</p>	<p>III.—Transportation and traffic expenses (<i>continued</i>).</p> <p>b. Traffic expenses (stations, &amp;c.) :—</p> <ol style="list-style-type: none"> <li>1. Superintendence.</li> <li>2. Stationmasters and clerks (salaries and wages).</li> <li>3. Porters (wages).</li> <li>4. Signalmen and gatekeepers (wages).</li> <li>5. Checkers (wages).</li> <li>6. Shunters (wages).</li> <li>7. Other staff (wages).</li> <li>8. Uniforms.</li> <li>9. Travelling expenses.</li> <li>10. Stationery and printing.</li> <li>11. Lighting and heating.</li> <li>12. Water.</li> <li>13. Stores and equipment.</li> <li>14. Other expenses.</li> </ol> <p>(c) Advertising and canvassing:</p> <ol style="list-style-type: none"> <li>1. Salaries and wages.</li> <li>2. Commissions.</li> <li>3. Advertising.</li> <li>4. Other expenses.</li> </ol> <p>(d) Compensation :—</p> <ol style="list-style-type: none"> <li>1. Personal.</li> <li>2. Goods and live stock.</li> <li>3. Damage to property.</li> </ol>
IV.—General charges.	<p>IV.—General charges.</p> <p>a. General management.</p> <p>b. Accounting.</p> <p>c. Revision of rates and tariffs.</p> <p>d. Legal expenses.</p> <p>e. Other expenses.</p>	<p>IV.—General charges.</p> <p>a. General management :—</p> <ol style="list-style-type: none"> <li>1. Salaries and wages.</li> <li>2. Office and travelling expenses.</li> </ol> <p>b. Accounting :—</p> <ol style="list-style-type: none"> <li>1. Salaries and wages.</li> <li>2. Office and travelling expenses.</li> </ol> <p>c. Revision of rates and tariffs :</p> <ol style="list-style-type: none"> <li>1. Salaries and wages.</li> <li>2. Office and travelling expenses.</li> </ol> <p>d. Legal expenses.</p> <p>e. Other expenses.</p>

Annexure No. 5—*continued*.**Classification of Indirect (Suspense) Expenditure.**

In the above classification of working expenditure, it has been assumed that separate records are kept of expenditure on such services as the following, and charged out on some well-considered basis to the different departments or accounts which have benefited by such indirect expenditure:—

- Stores expenses;
- Electric light and power;
- Workshops expenses;
- Labour recruiting charges;
- Sick fund and superannuation fund contributions;
- Insurance premiums and expenses.

Although uniformity in the expense classifications of these separate accounts is not essential at the present time, some particulars are given below (based on the practice of the Central South African railways) both as to the heads of expenditure and the basis of distribution, as the adoption of different methods by different administrations affects to some extent the cost of the other services shown in the preceding classification of working expenditure proper.

**STORES EXPENSES.**

Heads of expenditure.	Basis of distribution.
<i>Superintendence :—</i>	
Salaries and wages ... ..	
Office and travelling expenses... ..	
<i>Other expenditure :—</i>	
Salaries and wages ... ..	A percentage is added to the value of stores issued to cover the stores department expenditure.
Offices ... ..	
Travelling allowances ... ..	
Sanitary charges ... ..	
Maintenance of stores buildings ... ..	
Miscellaneous expenditure ... ..	

**ELECTRIC LIGHT AND POWER.**

Heads of expenditure.	Basis of distribution.
<i>Superintendence :</i>	
Salaries and wages ... ..	
Office and travelling expenses... ..	
Wages, other than superintendence ... ..	Charged out to all departments using electric power and light according to consumption. (Cost of train and station lighting charged to traffic department.)
Materials ... ..	
Maintenance of buildings ... ..	
Miscellaneous expenses ... ..	
Purchase of power and light ... ..	
Depreciation of plant ... ..	

Annexure No. 5—*continued*.**Classification of Indirect (Suspense) Expenditure—*continued*.****SICK AND SUPERANNUATION FUNDS (CONTRIBUTIONS TO).**

Heads of expenditure.	Basis of distribution.
1. Contributions by administration to sick fund	1, 2 and 3. Charged out to departments in which employees are serving. 4. Charged to coloured labour account (see above).
2. Contributions by administration to pension fund ... ..	
3. Contributions by administration to sick fund to cover medical examination of applicants for employment ... ..	
4. Contributions by administration to sick fund for medical attendance on coloured labourers ... ..	

**INSURANCE.**

Heads of expenditure.	Basis of distribution.
1. <i>Fire insurance:</i>	1. Charged out to departments for which insurance is effected, but insurance of all buildings occupied by traffic department or in connection with running of trains is borne by maintenance department; insurance of cartage, catering quarters, and other <i>buildings</i> for which rent is charged is a debit to real estate account. Insurance of loco, workshops is a charge to workshops account, and of stores buildings to stores expenses. Insurance of contents in all cases is debited to the department in whose charge such contents are.
Premiums paid to companies ... ..	
" " to administration's fire fund	
Fire brigade pay and expenses... ..	
2. <i>Marine insurance:</i>	2. Charged to stores department and added to cost price of stores. 3. Charged to departments employing the workmen as a percentage on the wages paid.
Premium paid to companies ... ..	
" " to administration's fund ...	
3. <i>Workmen's compensation insurance:</i>	
Premiums paid to administration's fund ...	



Annexure No. 5—*continued*.Classification of Indirect (Suspense) Expenditure—*continued*.

## WORKSHOPS EXPENSES.—LOCOMOTIVE DEPARTMENT.

Heads of Expenditure.				Basis of distribution.
				The expenditure of the locomotive workshops is of two classes :—
Direct expenses	{	Wages	... ..	1. Wages of men actually employed on specific jobs and material used for such jobs (direct expenditure).
		Material	... ..	2. General expenses which cannot be assigned to particular jobs, such as general superintendence, consumable stores, workshops' stores expenses, power, light, &c., (indirect expenditure).
Indirect expenses	{	Workshops expenses :		These two classes are dealt with in the following manner :— <i>Direct expenditure</i> is charged out to the actual work. <i>Indirect expenditure</i> : A separate record is kept for each shop of all indirect expenditure, except item (d), and it is charged out by a percentage addition to the labour charges of any work passing through that particular shop. <i>Item (d)</i> : Use of machinery represents the expenditure for maintaining the machinery and for motive power for driving it, also charges for depreciation.
		(a) Superintendence	... ..	
		(b) Wages	... ..	
		(c) Material	... ..	
		(d) Use of machinery	... ..	
		(e) Other expenses	... ..	

## COLOURED LABOUR (RECRUITING AND OTHER CHARGES).

Heads of expenditure.	Basis of distribution.
<i>Superintendence :</i>	
Salaries and wages ... ..	
Office and travelling expenses ... ..	
<i>Recruiting expenses :</i>	<i>Recruiting expenses</i> charged out to all departments in proportion to number of natives supplied.
Recruiting fees ... ..	<i>Compound expenses</i> charged to departments in proportion to number of natives maintained in compounds.
Clothing, &c., for recruits (value recovered from wages) ... ..	
Railway fares ... ..	
<i>Compound expenses :</i>	<i>Superintendence and miscellaneous expenses</i> charged out to departments as a percentage on recruiting and compound expenses.
Salaries and wages ... ..	
Provisions ... ..	
Medical attendance ... ..	
Heating, lighting and maintenance of buildings, &c. ... ..	
<i>Miscellaneous expenses</i> ... ..	

## APPENDIX II.

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### RAILWAY COMPANIES (ACCOUNTS AND RETURNS) ACT, 1911.

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Be it enacted by the King's most Excellent Majesty, by and with the advice and consent of the Lords Spiritual and Temporal, and Commons, in this present Parliament assembled, and by the authority of the same as follows:—

1 *Yearly accounts and returns in form in First Schedule to be furnished to Board of Trade.*—(1) Every railway company shall annually prepare accounts and returns in accordance with the form set out in the First Schedule to this Act, and shall submit their accounts to their auditors in that form.

(2) The accounts and returns shall be signed by the officer of the company responsible for the correctness of the accounts or returns, or any part thereof, and, in the case of an incorporated railway company, by the chairman or deputy chairman of the directors of the company, and shall be made up for the year ending the thirty-first day of December, or such other day as the Board of Trade may fix in the case of any company or class of companies to meet the special circumstances of that company or class of companies.

(3) Every railway company shall forward six copies of the accounts and returns to the Board of Trade not later than sixty days after the expiration of the year for which the accounts and returns are made up, and, in the case of an incorporated railway company, shall forward a copy of the accounts and returns to any shareholder or debenture holder of the Company who applies for a copy.

(4) If any railway company fails to prepare or forward, in accordance with this section, such accounts and returns as are thereby required, the company shall be liable on summary conviction to a fine not exceeding five pounds for every day during which the default continues.

(5) If any account or return prepared and forwarded under this section is false in any particular to the knowledge of any person who signs the account or return or any part thereof, that person shall be liable on conviction on indictment to imprisonment with or without hard labour for a term not exceeding one year, or to a fine not exceeding one hundred pounds, and on summary conviction to a fine not exceeding fifty pounds.

2. *Filing of certain accounts by Registrar of Companies.*—(1) A copy of the accounts numbered 1 (a), 1 (b), 1 (c), 3, and 18 in Part I of the First Schedule to this Act, as forwarded to the Board of Trade in pursuance of this Act, shall be filed by the Registrar of Companies in England, and, if any part of the railway of a company is situated in Scotland or Ireland, also by the Registrar of Companies in Scotland or Ireland, as the case may be, and for that purpose the Board of Trade shall, on receiving copies of accounts and returns under this Act from a railway company furnish one of those copies to any Registrar by whom accounts are to be filed under this section.

(2) Any person may inspect the accounts filed by any Registrar of Companies in pursuance of this section on paying a fee of one shilling for each inspection as regards each railway company, and any person may require a copy or extract of any of those accounts to be certified by or on behalf of the Registrar on paying for the copy or extract such fee as the Board of Trade may appoint not exceeding sixpence for each folio of a certified copy or extract, or in Scotland for each sheet of two hundred words.

(3) The provisions of the Railway Companies Securities Act, 1866, requiring half-yearly accounts in connexion with loan capital shall cease to have effect, and in section fourteen of that Act (which relates to the declaration to be made on mortgage deeds and debenture stock certificates) "the officer responsible for the correctness of the declaration" shall be substituted for "the company's registered officer."

*3. Alteration of First Schedule by Board of Trade.*—(1) The Board of Trade may by order, made under this section, alter or add to the First Schedule to this Act in such manner as they think fit; and, on any such alteration or addition being made, this Act shall be construed as if those alterations or additions were made in the First Schedule thereto.

(2) When the Board propose to make any such alteration or addition, they shall publish in the London, Edinburgh, and Dublin Gazettes, notice of the proposal and of the place where copies of the proposed alterations or additions may be obtained, and of the time, not being less than one month, within which any objection or suggestion made with respect to the alterations or additions by or on behalf of persons affected must be lodged with the Board, and shall take such other steps as they think best adapted for giving information with respect to those matters to persons affected.

(3) The Board of Trade shall consider any objection or suggestion made by or on behalf of persons appearing to them to be affected, which is lodged within the required time, and give to any person lodging any such objection or suggestion an opportunity of communicating with the Board on the matter.

(4) Not less than one month and not more than three months after the expiration of the time within which objections must be lodged, notice may be given to the Board of Trade, by or on behalf of railway companies whose aggregate capital is not less than one third of the total aggregate capital of all railway companies in the United Kingdom, that the companies are not satisfied with the mode in which any objection lodged by a railway company has been dealt with, and in that case, unless the notice is withdrawn, the order of the Board shall be provisional only, and shall not take effect unless it is confirmed by Parliament.

(5) The Board of Trade may submit to Parliament a Bill for confirming any order made by them which requires to be so confirmed, and if, while any such Bill is pending in either House of Parliament, a petition is presented against any order comprised therein, the Bill, so far as it relates to the order, shall be referred to a Select Committee, or, if the two houses of Parliament think fit so to order, to a joint committee of those Houses, and the petitioner shall be allowed to appear and oppose as in the case of Private Bills.

(6) The Board of Trade shall (in addition to the powers given to them under the foregoing provisions of this section) have power on the application of any company, to make as respects that company any special variation in the form of the accounts and returns set out in the First Schedule to this Act which appears to the Board to be required for the purpose of adapting the form to the particular circumstances of that company

*4. Removal of obligation to prepare half-yearly accounts.*—(1) A railway company shall not be under any obligation to prepare or to submit to their shareholders or auditors, statements of accounts or balance sheets, or to hold

ordinary general meetings more than once a year, and anything which under any special Act is authorised or required to be done at a general meeting of a railway company to be held at any specified time may be done at the annual general meeting of the company at whatever time held:

Provided that nothing in this provision shall relieve a railway company of any obligation to prepare half-yearly accounts in cases where those accounts are required in connexion with any guarantee of dividend under any such statutory provisions.

(2) The directors of an incorporated railway company may, if it appears to them that the profits of the company are sufficient, declare and pay an interim dividend for the first half of any year, notwithstanding that the accounts are not audited for the half-year, and that a statement of accounts and balance sheet for the half-year is not submitted to the shareholders, and may close their register and books of transfer before the date on which the interim dividend is declared in the same manner and for the same time and subject to the same provisions as they may close their register or books before the date on which their ordinary dividend is declared or before the date of their ordinary meeting.

(3) Any statutory provisions affecting the railway company shall be read with the modifications necessary to bring them into conformity with this section

5. *Saving for power to call for returns under 34 and 35 Vict. c. 78 and 51 and 52 Vict. c. 25.*—Nothing in this Act shall affect or limit any obligations imposed upon a railway company or any powers or rights conferred upon the Board of Trade by section nine of the Regulation of Railways Act, 1871, as amended by section thirty-two of the Railway and Canal Traffic Act, 1888, but the returns required of a railway company by those sections shall only be made at the instance of the Board of Trade and at such times as the Board of Trade may direct.

6. *Definitions and supplemental.*—(1) In this Act—

the expression “railway company” means any company or person working a railway under lease or otherwise, and the expression “railway” means a railway authorised by special Act;

the expression “special Act” includes any certificate or order having the force of an Act, and the expression “statutory provisions” includes the provisions of any such certificate or order;

the expression “Registrar of Companies” means the officer performing the duty of the registration of companies under the Companies (Consolidation) Act, 1908, in England, Scotland, or Ireland, as the case may be;

the expression “shareholder” means the holder of any share or part of any stock or other capital of a railway company which is not raised by means of borrowing or has not the character of borrowed money, and the expression “debenture holder” means the holder of any debenture or part of any debenture stock or other capital of a railway company which is raised by means of borrowing or has the character of borrowed money.

(2) Where any light railway company or other railway company are exempted by virtue of any special Act from the operation of sections nine and ten of the Regulation of Railways Act, 1871, as respects their railway or any part of their railway, that company shall, so far as regards that railway or part of the railway, be exempt from the obligation to prepare, submit, and forward accounts and returns under this Act; and the Board of Trade may exempt any company or authority from that obligation if they are satisfied

that the business of a railway company is merely subsidiary to the main business carried on by the company or authority, and that the company or authority are under an obligation to prepare their accounts in a form prescribed by the Board of Trade or to present them to Parliament.

(3) Where a railway is being managed or worked by a joint committee or other body representing two or more railway companies and the receipts and expenditure of that railway are separately treated under Abstract J. in the accounts and returns prepared and forwarded by the several companies whom the committee or body represents, the committee or body shall, for the purpose of the provisions of this Act with respect to accounts and returns, be deemed to be a separate railway company.

7. *Repeal, short title, and commencement.*—(1) The Acts specified in the Second Schedule to this Act are hereby repealed to the extent mentioned in the third column of that schedule.

(2) This Act may be cited as the Railway Companies (Accounts and Returns) Act, 1911, and shall come into operation on the first day of January nineteen hundred and thirteen.



## SCHEDULES.

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### FIRST SCHEDULE.

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No. 2.	Share Capital and Stock created, as per Statement No. 1 (a), showing the proportion issued.
No. 3.	Capital raised by Loans and Debenture Stock.
No. 4.	Receipts and Expenditure on Capital Account.
No. 4 (a)	Subscriptions to other Companies.
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## PART II.

## STATISTICAL RETURNS.

- I. Mileage of Lines—
  - (A)—Mileage of Lines open for Traffic.
  - (B)—Mileage of Lines authorised but not open to Traffic.
  - (C)—Mileage of Lines run over by the Company's Engines.
- II. Rolling Stock—
  - (A)—Steam Locomotives and Tenders.
  - (B)—Rail Motor Vehicles.
  - (C)—Trains worked by Electric Power.
  - (D)—Coaching Vehicles (other than Electric).
  - (E)—Merchandise and Mineral Vehicles.
  - (F)—Railway Service Vehicles, and Horses for Shunting.
- III. Horses and Road Vehicles employed in the Collection and Delivery of Parcels, Goods, and Passengers.
- IV. Steamboats.
- V. Canals.
- VI. Docks, Harbours, and Wharves.
- VII. Hotels.
- VIII. Land, Property, &c., not forming part of the Railway or Stations.
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- XIII. Passenger Traffic and Receipts.
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- XV(A). Tonnage of the Principal Classes of Minerals and Merchandise carried by Goods Trains.
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- Auditors' Certificate.
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- Map.



No. 1 (C).—NOMINAL CAPITAL AUTHORISED, AND CREATED BY SOME OTHER COMPANY ON WHICH THE COMPANY EITHER JOINTLY OR SEPARATELY GUARANTEES FIXED DIVIDENDS.

Special Acts.	Capital authorised.			Capital created.			Balance.		
	Shares and Stock.	Loans or Debenture Stock.	Total.	Shares and Stock.	Loans or Debenture Stock.	Total.	Shares and Stock.	Loans or Debenture Stock.	Total.
	£	£	£	£	£	£	£	£	£
[NOTE.—It should be stated in each case whether the dividend is guaranteed jointly with some other company or companies (the names of which should be given) or separately.]									

No. 2.—SHARE CAPITAL AND STOCK CREATED, AS PER STATEMENT No. 1 (A), SHOWING THE PROPORTION ISSUED.

Description.	Amount created.	Amount issued.	Nominal additions to or deductions from capital.	Amount on which dividend is payable.	Amount which does not rank for dividend until a future date.	Calls in arrear.	Amount uncalled.	Amount unissued.
	£	£	£	£	£	£	£	£
[Each class of shares and stock to be stated in order of date of creation, with the preferential or fixed dividends, if any, to which it is entitled, and any other conditions attached to it.]								
Total ... ..								

NOTE.—A column to be provided where necessary between "Amount created" and "Amount issued" to show "Additional Stock issued to provide authorised money."

## No. 3.—CAPITAL RAISED BY LOANS AND DEBENTURE STOCK.

	Raised by Loans.					Raised by issue of Debenture Stocks.					Total raised by Loans or Debenture Stocks.	
	At per cent.	At per cent.	At per cent.	At per cent.	Total Loans.	Amount of Stock.	Nominal additions or deductions on Conversion.	Existing amount of Stock.				
								At per cent.	At per cent.	At per cent.		Total Debenture Stock.
Existing at	£	£	£	£	£	£	£	£	£	£	£	
Existing at												
Increase												
Decrease												

Total amount authorised to be raised by Loans and Debenture Stocks in respect of Capital created as per Statement No. 1 (A)... ..

*Less*—Amount created but not yet available ... ..

Reduction of borrowing power in respect of interest paid out of capital ... ..

Capitalised value of rent charges, annuities or feu duties, in accordance with Section 5 of the Lands Clauses Consolidation Acts Amendment Act, 1860 ... ..

Other deductions, if any ... ..

Total deductions ... ..

Total amount raised by Loans and Debenture Stock as above ... ..

Balance being available borrowing powers at ... ..



## NO. 4.—RECEIPTS AND EXPENDITURE ON CAPITAL ACCOUNT.

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To Expenditure.	Amount expended to—	Amount expended during the year as per No. 5.	Total.	By Receipts.	Amount received to—	Amount received during year.	Total.
	£	£	£		£	£	£
Lines open for traffic ...							
Lines not open for traffic:							
New lines ... ..				Shares and Stocks (No. 2) ... ..			
Widening of exist- ing lines ... ..							
Lines leased ... ..				Loans (No. 3) ...			
Lines, jointly owned ...							
Lines, jointly leased ...				Debenture Stock (No. 3) ... ..			
Rolling stock ... ..							
Manufacturing and re- pairing works and plant:—							
Land and buildings							
Plant and machinery							
Total capital expended on railway ... ..							
Horses ... ..				Premiums on Shares and Stocks ..			
Road vehicles employed in the collection and delivery of parcels, goods, and passen- gers:—				Premiums on Debenture Stock ...			
1. Goods and par- cels road vehicles							
2. Passenger road vehicles ... ..				Total premiums ...			
Steamboats ... ..							
Canals ... ..							
Docks, harbours and wharves ... ..				Discounts on Shares and Stocks ...			
Hotels ... ..							
Electric power stations, &c.							

No. 4.—RECEIPTS AND EXPENDITURE ON CAPITAL ACCOUNT.—*contd.*

To Expenditure.	Amount expended to—	Amount expended during year as per No. 5.	Total.	By Receipts.	Amount received to—	Amount received during year.	Total.
	£	£	£		£	£	£
Land, property, &c., not forming part of the railway or stations:—				Discounts on Debenture Stock ...			
(a) Used in connec- tion with railway working ...				Total discounts ...			
(b) Not used in con- nection with rail- way working ...							
Other industries:— (To be stated sepa- rately)							
Subscriptions to other companies (for de- tails see Table below, No. 4 (A)) ... ..				Balance of pre- miums and dis- counts ... ..			
Special items ... ..							
Total expenditure ...				Total Receipts ...			
To Balance ... ..				By Balance ... ..			
Total ... ..				Total ... ..			

## No. 5.—DETAILS OF CAPITAL EXPENDITURE FOR THE YEAR ENDING

	Land and compensation.	Construction of way and stations, engineering, &c.	Law charges and Parliamentary expenses.	Total.
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
Purchase of railways (particulars) ...				
Lines belonging to the company open for traffic (particulars) ...				
Lines belonging to the company not open for traffic :—				
New lines (particulars) ...				
Widenings of and additions to existing lines (particulars) ...				
Lines leased (particulars) ...				
Lines jointly owned (particulars) ...				
Lines jointly leased (particulars) ...				
Rolling stock :—				
Locomotives ...		(Number and type of each description to be shown in accord- ance with rolling stock returns)		
Coaching vehicles ...				
Wagons .. ...				
Service vehicles... ..				
Manufacturing and repairing works and plant (particulars) ...				
Horses .. ...				
Road vehicles employed in the collection and delivery of parcels, goods and passengers (particulars) ...				
Steamboats (particulars) ...				
Canals (particulars) ...				
Docks, harbours and wharves (particulars) ...				
Hotels (particulars) ...				
Electric power stations, &c. (particulars) ...				
Land, property, &c., not forming part of the railway or stations :—				
(a) Used in connection with railway working (particulars) ...				
(b) Not used in connection with railway working (particulars)...				
Subscriptions to other companies (particulars) ...				
(a) Railway companies ...				
(b) Other ...				
Special items (details to be given) ...				
Total capital expenditure for the year ...				

## No. 6.—ESTIMATE OF FURTHER EXPENDITURE ON CAPITAL ACCOUNT.

Expenditure to date on principal works in progress.		Estimated further expenditure		
		During the year ending	Subsequently until completion.	Total.
£		£	£	£
	Purchase of railways (particulars) ...			
	Lines belonging to the company open for traffic (particulars) ...			
	Lines belonging to the company not open for traffic :—			
	New lines (particulars) ...			
	Widenings of and additions to existing lines (particulars) ...			
	Lines leased (particulars) ...			
	Lines jointly owned (particulars) ...			
	Lines jointly leased (particulars) ...			
	Rolling stock ...			
	Manufacturing and repairing works and plant ...			
	Steamboats ...			
	Canals ...			
	Docks, harbours and wharves ...			
	Hotels ...			
	Electric power stations, &c. ...			
	Subscriptions to other companies ..			
	Special items ...			
	Miscellaneous ...			
	Total ...			
	Works not yet commenced and in abeyance ...			

## No. 7.—CAPITAL POWERS AND OTHER ASSETS AVAILABLE TO MEET FURTHER EXPENDITURE ON CAPITAL ACCOUNT.

	£	£
Stock, Share and Loan Capital authorised but not yet created (as per Statement No. 1 (A)) ...		
Stock and Share Capital created but not yet received (as per Statement No. 2):—		
Calls in arrear ...		
Amount uncalled ...		
Amount unissued ...		
Loan Capital created but not yet available (as per Statement No. 3)		
Available borrowing powers (as per Statement No. 3) ...		
<div> Add or Deduct </div> } balance at <div> Credit or Debit </div> (as per capital Account No. 4) ...		
Total ...		

## (Nos. 8 to 18 Revenue Accounts.)

## No. 8.—REVENUE RECEIPTS AND EXPENDITURE OF THE WHOLE UNDERTAKING.

See Statement.		Gross Receipts.	Expenditure.	Net Receipts.	Year 19 .		
					Gross Receipts.	Expenditure.	Net Receipts.
		£ s. d.	£ s. d.	£ s. d.	£	£	£
10	Railway ... ..						
11	Omnibuses and other passenger vehicles not running on the railways ... ..						
12	Steamboats ... ..						
13	Canals ... ..						
14	Docks, harbours and wharves						
15	Hotels and refreshment rooms and cars where catering is carried on by the company						
16	Other separate businesses carried on by the company (in detail) ... ..						
	Total ... ..	£					
Miscellaneous receipts (net):—							
	Rents from houses and lands ... ..						
	Rents from hotels ... ..						
	Other rents, including lump-sum tolls ... ..						
	Interest and dividends from investments in other companies (in detail) ... ..						
	Transfer fees ... ..						
	General interest ... ..						
	Special items ... ..						
	Total net income ... ..						



## No. 9.—PROPOSED APPROPRIATION OF NET INCOME.

		—	Year 19
		£ s. d.	£
Balance brought forward from last year's account ... ..			
Net income (as per statement No. 8) ... ..			
Appropriation from reserve ... ..			
Total ... ..			
Deduct.—Interest, rentals and other fixed charges (to be stated by each company in order of priority):—	£ s. d.		
Interest on superannuation and other funds ... ..			
Rent charges (or feu duties) and annuities ... ..			
Chief rents, wayleaves, &c., including lump-sum tolls ... ..			
Interest on loans ... ..			
Interest on Debenture Stocks (details) ... ..			
Rent of and guaranteed interest on leased and worked lines ... ..			
Interest on Lloyd's bonds ... ..			
General interest... ..			
Special items (if any) ... ..			
Total ... ..			
Balance after payment of fixed charges ... ..			
Appropriation to Reserve and other special pur- poses:—	£ s. d.		
(Details)			
Total ... ..			
Dividends on Guaranteed and Preference Stocks:—	£ s. d.		
(Details)			
Total ... ..			
Balance available for dividends on Ordinary Stock:—	£ s. d.		
(Details)			
Total ... ..			

## No. 9 (A).—STATEMENT OF INTERIM DIVIDENDS PAID.

		—	Year 19
		£ s. d.	£
Balance available for dividends, year 19 ... ..			
Deduct:	£ s. d.		
Interim dividends paid (particulars) ... ..			
Undivided balance at 31st December, carried to balance sheet			

Dr.

No. 10.—RECEIPTS AND EXPENDITURE

To Expenditure.				Year 19 .	Percentage of Traffic Receipts.	
					...	...
See Abstracts.				£ s. d.	£	%
<b>A : Maintenance and renewal of way and works</b> ...						
<b>B : Maintenance and renewal of rolling stock :—</b>						
				£ s. d.		
(1) Locomotives ... ..						
(2) Carriages ... ..						
(3) Wagons ... ..						
				£ s. d.		
<b>C Locomotive running expenses</b> ...						
<b>D Traffic expenses</b> ... ..						
<b>E General charges</b> ... ..						
Law charges ... ..						
Parliamentary expenses ... ..						
Compensation (accidents and losses) :—				£ s. d.		
Passengers ... ..						
Workmen ... ..						
Damage and loss of goods, property, &c. ... ..						
Rates ... ..						
Taxes ... ..						
Government duty ... ..						
<b>G Running powers (balance, debit or credit)</b> ...						
Total traffic expenditure ...				£		
<b>J : Joint lines*</b> ... ..						
Miscellaneous ... ..						
Total expenditure ... ..				£		
Net receipts ... ..				£		
Total ... ..				£		

NOTE.—Gross receipts to include the whole of the receipts from traffic carried line by trains of other companies and no annual payment is made therefor, or where accruing to other companies in respect of running powers exercised by them over receipts in this statement, but to be entered as a payment in the Running Powers page in respect of trains run by the company over the lines of other companies to the Running Powers Account.

\* Under this heading should be entered only the expenditure or receipts of by or for the Joint Committee and are not already embodied in those of the proportion of the revenue and expenditure to be spread over the various heads on

## IN RESPECT OF RAILWAY WORKING.

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By Gross Receipts.	—	—	Year 19	Percentage of Traffic Receipts.	
				...	...
See Abstracts.	£ s. d.	£ s. d.	£	%	%
Passenger train traffic:—					
Ordinary passengers:					
First class ... ..					
Second class ... ..					
Third class ... ..					
Season tickets:					
First class ... ..					
Second class ... ..					
Third class ... ..					
Workmen's tickets ... ..					
Total receipts from passengers ...					
Mails ... ..					
Parcels up to 2 cwt., parcels post, and excess luggage ... ..					
Other merchandise by passenger trains ..					
F: Less expenses of collection and delivery ...					
Total passenger train receipts... ..					
Goods train traffic:—	£ s. d.				
Merchandise ... ..					
F: Less expenses of collection and delivery ... ..					
Livestock ... ..					
Coal, coke, and patent fuel ... ..					
Other minerals ... ..					
Total goods train receipts ... ..					
Total traffic receipts ... ..	£				
H: Mileage, demurrage, and wagon hire ... ..					
J: Joint lines* ... ..					
Miscellaneous ... ..					
Total ... ..	£				

over the company's lines, except where (a) the traffic is carried over the company's (b) the payment made is by way of a fixed rent. The proportion of traffic receipts the company's lines not to be treated as a deduction from the company's traffic Account (Abstract G). The proportion of the traffic receipts accruing to the com- be excluded from the traffic receipts in this statement, and entered as receipts in

jointly owned and jointly leased lines in respect of which the accounts are prepared parent companies (*see* Abstract J). In the case of other joint lines the company's the respective sides of this account.

## ABSTRACT A.—MAINTENANCE AND RENEWAL OF WAY AND WORKS.

				Year 19 .
	£	s.	d.	£
Superintendence—				
Salaries ... ..				
Office expenses ... ..				
Maintenance of roads, bridges and works—				
Earthworks... ..				
Bridges, tunnels, culverts, retaining walls, and other works ... ..				
Roads and fences ... ..				
Maintenance of permanent way—				
Renewal of running lines—				
Wages ... ..				
Materials ... ..				
Engine power and wagon repairs ... ..				
Repair of running lines and sidings—				
Wages ... ..				
Materials ... ..				
Engine power and wagon repairs ... ..				
Maintenance of signalling ... ..				
Maintenance of telegraphs ... ..				
Maintenance of stations and buildings—				
Stations, depôts, and offices... ..				
Engine sheds ... ..				
Carriage sheds ... ..				
Locomotive workshops ... ..				
Carriage workshops ... ..				
Wagon workshops ... ..				
Other buildings ... ..				
Total ... ..	£			

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

## ABSTRACT B.—MAINTENANCE AND RENEWAL OF ROLLING STOCK.

## (1).—Locomotives.

								Year 19 .
						£ s. d.	£ s. d.	£
Superintendence—								
Salaries ...	...	...	...	...	...			
Office expenses ...	...	...	...	...	...			
Complete renewals—								
Wages ...	...	...	...	...	...			
Materials ...	...	...	...	...	...			
Repairs and partial renewals—								
Wages ...	...	...	...	...	...			
Materials ...	...	...	...	...	...			
Purchase of new locomotives ...	...	...	...	...	...			
Workshop expenses—								
Repairs and renewals of machinery and plant								
Other expenses ...	...	...	...	...	...			
Total ...	...	...	...	...	...	£		

## (2).—Carriages.

								Year. 19
						£ s. d.	£ s. d.	£
Superintendence—								
Salaries ...	...	...	...	...	...			
Office expenses ...	...	...	...	...	...			
Complete renewals—								
Wages ...	...	...	...	...	...			
Materials ...	...	...	...	...	...			
Repairs and partial renewals—								
Wages ...	...	...	...	...	...			
Materials ...	...	...	...	...	...			
Purchase of new carriages ...	...	...	...	...	...			
Workshop expenses—								
Repairs and renewals of machinery and plant								
Other expenses ...	...	...	...	...	...			
Total ...	...	...	...	...	...	£		

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.



## (3).—Wagons.

							Year 19 .
					£ s. d.	£ s. d.	£
Superintendence—							
Salaries ... ..							
Office expenses ... ..							
Complete renewals—							
Wages ... ..							
Materials ... ..							
Repairs and partial renewals—							
Wages ... ..							
Materials ... ..							
Purchase of new wagons ... ..							
Workshop expenses—							
Repairs and renewals of machinery and plant							
Other expenses ... ..							
Total ... ..					£		

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

## ABSTRACT C.—LOCOMOTIVE RUNNING EXPENSES.

							Year 19 .
					£ s. d.	£ s. d.	£
Superintendence—							
Salaries ... ..							
Office expenses ... ..							
Steam train working—							
Wages connected with the running of loco-							
motive engines ... ..							
Fuel ... ..							
Water ... ..							
Lubricants ... ..							
Other stores, including clothing ... ..							
Miscellaneous ... ..							
Electric train working—							
Wages of motormen... ..							
Electric current ... ..							
Lubricants ... ..							
Other stores, including clothing ... ..							
Total ... ..					£		

NOTE.—Any other form of power to be shown separately with corresponding details.

## ABSTRACT D.—TRAFFIC EXPENSES.

	—	—	Year 19 .
	£ s. d.	£ s. d.	£
Salaries and wages :			
Superintendence ... ..			
Stationmasters and clerks ... ..			
Signalmen and gatemen ... ..			
Ticket collectors, policemen, porters, &c. ...			
Guards ... ..			
Fuel, lighting, water, and general stores ... ..			
Clothing ... ..			
Printing, advertising, stationery, stamps and tickets ...			
Wagon covers, &c. ... ..			
Expenses of joint stations and junctions... ..			
Cleansing, lubricating, and lighting of vehicles ...			
Shunting expenses (other than mechanical) ... ..			
Working of stationary engines, hoists, cranes, &c. ...			
Coal, &c., tipping expenses ... ..			
Railway clearing house expenses .. ..			
Miscellaneous expenses ... ..			
Total ... ..	£		

## ABSTRACT E.—GENERAL CHARGES.

	—	Year 19 .
	£ s. d.	£
Directors' fees voted by shareholders ... ..		
Fees paid to and expenses of directors on joint committees not included in Abstract J ... ..		
Auditors and public accountants (fees, clerkage and expenses)		
Salaries of secretary, general manager, accountant and clerks		
Office expenses, ditto ... ..		
Rating expenses ... ..		
Fire insurance ... ..		
Superannuation and benevolent funds, pensions, &c. ...		
Subscriptions and donations * ... ..		
Miscellaneous expenses ... ..		
Total ... ..		

\* Amounts contributed to institutions not directly controlled by the company and not for the exclusive benefit of the company's servants.

## ABSTRACT F.—EXPENSES OF COLLECTION AND DELIVERY OF PARCELS AND GOODS.

							Year 19	
							£ s. d.	£
Salaries and wages	...	...	...	...	...	...		
Rents, rates and taxes	...	...	...	...	...	...		
Maintenance of horses	...	...	...	...	...	...		
Maintenance of horse vehicles	...	...	...	...	...	...		
Maintenance of motors	...	...	...	...	...	...		
Amounts paid for hired cartage	...	...	...	...	...	...		
Miscellaneous	...	...	...	...	...	...		
Total	...	...	...	...	...	...		
Amount charged to passenger train traffic								
Amount charged to goods traffic								

NOTE.—The division of expenditure to be based as far as possible on actual figures.

## ABSTRACT G.—RUNNING POWERS.

## RECEIPTS AND PAYMENTS IN RESPECT OF RUNNING POWER EXPENSES.

				Year 19 .		
				Receipts.*	Payments.†	Balance.
				£	£	£
Passenger train traffic	...	...	...			
Goods train traffic	...	...	...			
Total	...	...	...			

\* Receipts are the sums received by a company in respect of trains run by it over the lines of other companies.

† Payments are the sums paid by a company in respect of trains run by other companies over its lines.

## ABSTRACT H.—MILEAGE, DEMURRAGE AND WAGON HIRE.

				Year 19 .		
	Receipts.	Expenditure.	Balance.	Receipts.	Expenditure.	Balance.
	£ s. d.	£ s. d.	£ s. d.	£	£	£
Mileage and demurrage—						
Passenger train vehicles ...	...					
Goods train vehicles ...	...					
Hire of—						
Passenger train vehicles ...	...					
Goods train vehicles ...	...					
Total ...	...					

## ABSTRACT J.—JOINTLY OWNED AND JOINTLY LEASED LINES.

## RECEIPTS AND EXPENDITURE.

	Name of Joint line.		Name of Joint line.		Name of Joint line.		Total.	Year 19 .	Total.
	£	£	£	£	£	£	£	£	£
Gross receipts—									
(Details to follow State- ment No. 10) ...									
Total receipts ...									
Total receipts, company's proportion ...									
Expenditure—									
(Details to follow State- ment No. 10) ...									
Total expenditure ...									
Total expenditure, com- pany's proportion ...									

NOTE.—In this abstract should be entered only the receipts and expenditure of jointly owned and jointly leased lines in respect of which the accounts are prepared by or for the joint committee, and are not embodied under their respective headings in the accounts of the parent companies.

**NO. 11.—RECEIPTS AND EXPENDITURE IN RESPECT OF OMNIBUSES AND OTHER  
PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.**

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				
.. .. motors ...				
.. .. buildings ...				
Traffic expenses ...				
Miscellaneous ...				
Total expenditure				
Balance ...				
Total ...				

PASSENGER VEHICLES NOT RUNNING ON THE RAILWAY.				
Dr.			Cr.	
To Expenditure.	£	s.	d.	Year 19 .
Maintenance of horses ...				£
.. .. horse vehicles				

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

**NO. 12.—RECEIPTS AND EXPENDITURE IN RESPECT OF STEAMBOATS.**

Dr.					Cr.												
To Expenditure.					£	s.	d.	Year 19 .	By Gross Receipts.					£	s.	d.	Year 19 .
Salaries and wages ...									Passengers ... ..								
Fuel ... ..									Parcels ... ..								
Stores, lubricants, water, &c. ... ..									Mails ... ..								
Repairs ... ..									Merchandise ... ..								
Harbour fees and light dues ... ..									Livestock ... ..								
Miscellaneous ... ..									Miscellaneous ... ..								
Working expenses ... ..																	
Depreciation and Insurance																	
Total expenditure ... ..																	
Balance ... ..																	
Total ... ..									Total ... ..								



## No. 13.—RECEIPTS AND EXPENDITURE IN RESPECT OF CANALS.

Dr.			Cr.		
To Expenditure.	£ s. d.	Year 19 .	By Gross Receipts.	£ s. d.	Year 19 .
		£			£
Superintendence ...			Tolls ... ..		
Wages of toll clerks, lock-keepers, &c.			Freight as carriers ...		
Maintenance of canal ...			Canal dock dues ...		
Water supply ... ..			Wharfage and cramage		
Auxiliary tramway expenses			Rents (net receipts) ...		
Traffic expenses as carriers			Miscellaneous ...		
Rates ... ..					
Taxes ... ..					
Miscellaneous ... ..					
Total expenditure ...					
Balance ... ..					
Total ... ..			Total... ..		

## No. 14.—RECEIPTS AND EXPENDITURE IN RESPECT OF DOCKS, HARBOURS AND WHARVES.

Dr.			Cr.		
To Expenditure.	£ s. d.	Year 19 .	By Gross Receipts.	£ s. d.	Year 19 .
		£			£
Superintendence ...			Harbour dues ... ..		
Maintenance ... ..			Light dues ... ..		
Dredging ... ..			Dock dues :—		
Wages not included in above			On ships ... ..		
Rates ... ..			On goods ... ..		
Taxes ... ..			On passengers ...		
Miscellaneous ... ..			Wharf and pier dues ...		
Total expenditure ...			Cramage and other services		
Balance ... ..			Graving docks ...		
			Rents ... ..		
			Miscellaneous ...		
Total ... ..			Total ... ..		

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

**No. 15.—RECEIPTS AND EXPENDITURE IN RESPECT OF HOTELS, AND OF REFRESHMENT ROOMS AND CARS WHERE CATERING IS CARRIED ON BY THE COMPANY.**

Dr.

Cr.

To Expenditure.	£	s.	d.	Year 19 .	By Gross Receipts.	£	s.	d.	Year 19 .
				£					£
Salaries and wages ...					Total receipts from hotels and from sale of provisions, &c., in refreshment rooms and cars ... ..				
Provisions, wines and spirits consumed ...									
* Repairs and maintenance of hotels and refresh- ment rooms and of fit- tings, furniture, &c., of refreshment cars ...									
Heating and lighting of hotels and refreshment rooms ... ..									
Rents ... ..									
Rates in respect of hotels ...									
Taxes in respect of hotels ...									
Miscellaneous ... ..									
Total expenditure ...									
Balance ... ..									
Total ... ..					Total ... ..				

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

\* To include in the case of hotels and refreshment rooms expenditure on buildings, furniture and plant.

**No. 16.—RECEIPTS AND EXPENDITURE IN RESPECT OF OTHER SEPARATE BUSINESSES CARRIED ON BY THE COMPANY.**

## No. 17.—ELECTRIC POWER AND LIGHT ACCOUNT.

	—	—	Year 19 .	—	—	—	Year 19 .
	£ s. d.	£ s. d.	£		Number of units.	£ s. d.	Number of units.
Superintendence :—							
Salaries ...							
Office expenses ...							
Total Superin- tendence ...				Current sup- plied :—			
				For traction...			
Generation :—				For power ...			
Maintenance of buildings ...				For lighting...			
Maintenance of plant, machinery, and tools ...				To other con- sumers ...			
Maintenance of feeders, cables, and accessories ...							
Salaries and wages							
Fuel, including carriage, &c. ...							
Oil, waste, water, and stores ...							
Special items ...							
Total generation							
Distribution :—							
Maintenance of feeders, mains, and apparatus ...							
Maintenance of meters, switches, fuses, lamps, &c.							
Salaries and wages							
Royalties, &c., pay- able for use of patents ...							
Rents payable ...							
Rates ...							
Taxes ...							
Special charges :— (To be enumerated)							
£				Total ...			

NOTE.—When any sum is transferred to or from a depreciation fund or suspense account, the net sum to be stated.

Dr.

No. 18.—GENERAL BALANCE SHEET.

Cr.

	—	Year 19 .	—	—	Year 19 .
To capital account, balance at credit thereof, as per Account No. 4...	£ s. d.	£	By capital account, balance at debit thereof as per Account No. 4 ...	£ s. d.	£
Amount due to bankers ...					
Temporary loans and calls paid in advance ...			£ s. d. Cash at bankers and in hand...		
Lloyd's bonds ...			Cash on deposit at interest ...		
Unpaid interest and dividends ...			Investments in consols and government securities ...		
Interest and dividends payable or accruing and provided for ...			Investments in stocks and shares held by the company, not charged as capital expenditure...		
Amount due to railway companies and com- mittees ...			Investment of super- annuation and other provident funds ...		
Amount due to railway clearing houses ...			Stock of stores and materials ...		
Savings bank ...			Outstanding traffic accounts ...		
Superannuation and other provident funds ...			Amount due by rail- way companies and committees ...		
Accounts payable ..			Amount due by rail- way clearing houses...		
Liabilities accrued ...			Amount due by Post- master-General ...		
Miscellaneous accounts ...			Accounts receivable ...		
Special items (to be detailed) ...			Miscellaneous accounts		
Fire insurance fund ...			Suspense accounts (if any) to be enumerated		
Depreciation funds— railway ...			Special items (to be de- tailed) ...		
Steamboats (including insurance fund) ...					
Other businesses ...					
General reserve fund ...	£ s. d.				
Balance available for dividends and reserve as per Account No. 9 ...					
Less interim divi- dends paid as per Statement No. 9 (A) ...					

## PART II.—STATISTICAL RETURNS.

## I.—MILEAGE OF LINES.

## (A).—Mileage of Lines open for Traffic.

	Running Lines.						Sidings reduced to single track.	Total of single track, including sidings.	Year 19 .
	Length of road. First track.	Second track.	Third track.	Fourth track.	Over four tracks (reduced to single track).	Total miles (reduced to single track).			
Lines owned by company:	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.
Main and principal lines:—									
(Details) ...									
Total of main and principal lines ...									
Minor and branch lines (summarised by districts):—									
(Details) ...									
Total ...									
Lines jointly owned (company's share of ownership):									
As enumerated in Abstract J:—									
(Details) ...									
Total ...									
Other joint lines ...									
Total lines jointly owned ...									
Total miles of lines owned and company's share of lines jointly owned									
Ditto year 19 ...									
Lines leased or worked:									
By the company:—									
(Details) ...									
Total ...									
Jointly with other companies (company's share):									
As enumerated in Abstract J:—									
(Details) ...									
Total ...									



## Part II.—Statistical Returns—continued.

	Running Lines.						Sidings reduced to single track.	Total of single track, including sidings.	Year 19 .
	Length of road. First track.	Second track.	Third track.	Fourth track.	Over four tracks (reduced to single track).	Total miles (reduced to single track).			
	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.	m. c.
Other jointly leased or worked lines ...									
Total miles of lines leased or worked and company's share of lines jointly leased or worked ...									
Grand total ...									
Ditto year 19 ...									

## (B).—MILEAGE OF LINES AUTHORISED BUT NOT OPEN FOR TRAFFIC.

	Miles Authorised.	Miles Constructed and not open for Traffic.		Miles under Construction.	Miles not commenced, or in Abeyance.
	Length of Road.	Length of Road.	Length (including Sidings) reduced to Single Track.	Length of Road.	Length of Road.
	m. c.	m. c.	m. c.	m. c.	m. c.
Lines owned by the company—					
New lines:					
(Details) ...					
Total ...					
Ditto year 19 ...					
Widenings and additions:					
(Details) ...					
Total ...					
Ditto year 19 ...					
Joint lines (company's share of ownership):—					
New lines ...					
Ditto year 19 ...					
Widenings and additions ...					
Ditto year 19 ...					

## (C).—MILEAGE OF LINES RUN OVER BY THE COMPANY'S ENGINES.

—						M. Ch.	Year 19 M. Ch.
Lines owned by the company	...	...	...	...	...		
„ partly owned	...	...	...	...	...		
„ leased, or worked by the company	...	...	...	...	...		
„ leased, or worked jointly	...	...	...	...	...		
„ over which the company exercises running powers	...	...	...	...	...		
Total	...	...	...	...	...		

## II.—ROLLING STOCK.

## A.—Steam Locomotives and Tenders.

—						—	Year 19 .
Description.						Number.	Number.
Tender engines:— (Wheel types to be stated)	...	...	...	...	...		
Tank engines:— (Wheel types to be stated)	...	...	...	...	...		
Tenders	...	...	...	...	...		

## B.—Rail Motor Vehicles.

—				—	—	Year 19 .	
—				Number.	Carrying capacity.	Number.	Carrying capacity.
					Seats.		Seats.
Steam power	...	...	...				
Petrol power	...	...	...				
Other power (self-contained)			...				
Total	...	...	...				

## C.—Trains Worked by Electric Power.

—	—	—	Year 19 .	
—	Number.	Carrying capacity.	Number.	Carrying capacity.
Details to be filled in, as instructed by the Board of Trade from time to time, by individual companies with regard to the various systems in use ... ..		Seats.		Seats.

## D.—COACHING VEHICLES (OTHER THAN ELECTRIC).

—	Number.	Seats or berths.				Year 19 .	
		1st class.	2nd class.	3rd class.	Total.	Number.	Seats or berths, total.
Passenger carriages—							
Carriages of uniform class ...							
Composite carriages ... ..							
Restaurant cars ... ..							
Miscellaneous ... ..							
Total ... ..							
Sleeping ... ..							
Total passenger carriages ...							
Other Coaching Vehicles—							
Post Office vans — ...							
Luggage, parcel and brake vans							
Carriage trucks ... ..							
Horse boxes ... ..							
Miscellaneous ... ..							
Total other coaching vehicles ... ..							
Total coaching vehicles ...							

## E.—MERCHANDISE AND MINERAL VEHICLES.

	—	Year 19 .	
		Number.	Number.
Open wagons—			
Under 8 tons ... ..			
8 and up to 12 tons... ..			
Over 12 and up to 20 tons ... ..			
Over 20 tons (other than special) ... ..			
Covered wagons—			
Under 8 tons ... ..			
8 and up to 12 tons... ..			
Over 12 and up to 20 tons ... ..			
Over 20 tons ... ..			
Mineral wagons (to be shown by companies owning separate mineral stock)—			
Under 8 tons ... ..			
8 and up to 12 tons... ..			
Over 12 and up to 20 tons ... ..			
Over 20 tons ... ..			
Special wagons (for loads of exceptional dimensions and weight) ... ..			
Cattle trucks... ..			
Rail and timber trucks (including twin trucks) ... ..			
Brake vans ... ..			
Miscellaneous ... ..			
Total ... ..			

## F.—RAILWAY SERVICE VEHICLES, AND HORSES FOR SHUNTING.

	—	Number.	Year 19 .	
			Number.	Number.
Gasholder trucks ... ..				
Locomotive coal wagons ... ..				
Ballast wagons ... ..				
Mess and tool vans ... ..				
Breakdown cranes ... ..				
Travelling cranes ... ..				
Miscellaneous ... ..				
Total ... ..				
Horses for shunting ... ..				

III.—HORSES AND ROAD VEHICLES EMPLOYED IN THE COLLECTION AND  
DELIVERY OF PARCELS, GOODS AND PASSENGERS.

—	Number.	Year 19 .
		Number.
Goods and parcels road vehicles—		
Road motors for goods and parcels ... ..		
Horse wagons and carts ... ..		
Miscellaneous ... ..		
Total ... ..		
Passenger road vehicles—		
Road motors ... ..		
Tramcars ... ..		
Omnibuses ... ..		
Cabs ... ..		
Miscellaneous ... ..		
Total ... ..		
Horses for road vehicles ... ..		

IV.—STEAMBOATS.

—	Date of construction.	Indicated horse-power.	Registered tonnage.
Steamboats over 250 tons net... ..			Tons.
(Name of each to be given.)			
Total ... ..	Number.		
Ditto year 19 ... ..			
	Number.	Total horse- power.	Total registered tonnage.
Steamboats of 250 tons net and under			
Grand total ... ..			
Ditto year 19 ... ..			



## V.—CANALS.

Name.	Length in miles.
Total length ... ..	

## VI.—DOCKS, HARBOURS AND WHARVES.

Name.	Length of quay.

## VII.—HOTELS.

Name.	Situation.

## VIII.—LAND, PROPERTY, &amp;c., NOT FORMING PART OF THE RAILWAY OR STATIONS.

Land.	Acreage.	Year 19 .
		Acreage.
Agricultural land ... ..		
Urban and suburban land ... ..		

Land, Property, &c., not forming part of the Railway or Stations.—*contd.*

Houses.	Number.	Year 19 .
		Number.
Labouring class dwellings ... ..		
Houses and cottages for companies' servants ... ..		
Other houses and cottages ... ..		

#### IX.—OTHER INDUSTRIES (IF ANY).

(The form to be in the discretion of the company.)

#### X.—MAINTENANCE AND RENEWAL OF WAY AND WORKS (ABSTRACT A).

—	—	Year 19 .
Quantities of principal materials used :—		
Ballast ... ..	Yards.	Yards.
Fencing ... ..	Miles.	Miles.
Rails ... ..	Tons.	Tons.
Sleepers ... ..	No.	No.
Miles maintained :—		
Miles of road... ..	No.	No.
Miles of road reduced to single track—		
(a) Running lines ... ..	No.	No.
(b) Sidings ... ..	No.	No.
Miles of track renewed ... ..	No.	No.

## XI.—MAINTENANCE AND RENEWAL OF ROLLING STOCK (ABSTRACT B).

				In com- pany's work- shops.	By con- tract.	Total.	Year 19 .  Total.
Locomotives renewed	...	...	Number				
"    repaired :							
Heavy repairs	...		"				
Light	"	...	"				
"    under or awaiting repair at end of year.*			"				
Rail motor and electric :							
Train vehicles, &c., renewed	...		"				
"    "    repaired :							
Heavy repairs			"				
Light	"		"				
"    "    under or await- ing repair at end of year.*			"				
Coaching vehicles :							
(a) Carriages renewed	...	...	"				
"    repaired :							
Heavy repairs	...		"				
Light	"	...	"				
"    under or awaiting re- pair at end of year.*			"				
(b) Others renewed	...	...	"				
"    repaired :							
Heavy repairs	...		"				
Light	"	...	"				
"    under or awaiting repair at end of year.*			"				
Wagons renewed	...	...	"				
"    repaired :							
Heavy repairs	...	...	"				
Light	"	...	"				
"    under or awaiting repair at end of year.*			"				

\* Total only to be shown.

## XII.—ENGINE-

				Train-miles. (Loaded trains.)			Train-miles. (Including empty trains run for traffic purposes on either the forward or return journey).		
				Coach- ing.	Goods.	Total.	Coach- ing.	Goods.	Total.
<b>A</b>	Miles run in relation to the com- pany's traffic receipts—								
	Over the company's system by the company's engines* ...								
	Over the company's system by other companies' engines† ...								
	Add company's proportion (accord- ing to ownership) of miles run on joint account over joint lines not included in Abstract J ...								
	Total	...	...						
<b>B</b>	Miles run in relation to the com- pany's expenditure—								
	By the company's engines over lines owned, leased, or worked by the company ...								
	By the company's engines over other companies' lines ...								
	Add company's proportion (accord- ing to ownership) of miles run on joint account over joint lines not included in Abstract J ...								
	Total	...	...						
<b>C</b>	Miles run by the company's engines—								
	Over lines owned, leased, or worked by the company... ...								
	Over all joint lines ...								
	Over other companies' lines ...								
	Total	...	...						

\* To include miles run by the company's engines over joint lines or other com-  
on a proportion of the gross receipts.

† To exclude miles run by such companies in cases where no toll is received and  
the gross receipts.

NOTE.—Miles run by (1) steam tender and tank engines, (2) electric traction,  
regards the various heads in C.





## XIII.—PASSENGER TRAFFIC AND RECEIPTS.

Class of passenger.	Number.	Receipts.	Average fare per passenger.	Number originating on the company's system.	Year 19 .			
					Number.	Receipts.	Average fare per passenger.	Number originating on the company's system.
Ordinary :		£	d.			£	d.	
1st class ...								
2nd „ ...								
3rd „ ...								
Workmen* ...								
Total ...								
Season :†								
1st class ...								
2nd „ ...								
3rd „ ...								

\* To be calculated on a single journey basis. † To be calculated on an annual basis.

NOTE.—Receipts in column 2 to be the receipts from passengers as given in Account No. 10; the number of passengers in column 1 to be the number corresponding thereto.

## XIV.—GOODS TRAFFIC AND RECEIPTS.

				Tonnage originating on the company's system.	Year 19 .			
	Tonnage.	Receipts.	Average receipt per ton.		Tonnage.	Receipts.	Average receipt per ton.	Tonnage originating on the company's system.
	Tons.	£	d.	Tons.	Tons.	£	d.	Tons.
Merchandise ...								
Coal, coke and patent fuel ...								
Other minerals								
Total ...								
	No.	—		Number originating on the company's system.	No.	—		Number originating on the company's system.
Live Stock ...								

NOTE.—Receipts in column 2 to be the goods train receipts as given in Account No. 10; the tonnage in column 1 to be the tonnage corresponding thereto.

XV. (A).—TONNAGE OF THE PRINCIPAL CLASSES OF MINERALS AND MERCHANDISE CARRIED BY GOODS TRAINS.

[The tonnage of the principal articles of traffic originating on each railway company's system to be separately stated; the principal articles of traffic to be agreed in the case of each company with the Board of Trade. Consignments of less than two tons may be omitted, but in that case the fact that they are omitted must be stated.]

XV. (B).—NUMBER OF LIVE STOCK CARRIED BY GOODS TRAINS.

						Number.	Year 19 . Number.
Horses	...	...	...	...	...		
Cattle	...	...	...	...	...		
Calves	...	...	...	...	...		
Sheep	...	...	...	...	...		
Pigs	...	...	...	...	...		
Miscellaneous	...	...	...	...	...		
Total	...	...	...	...	...		

XVI.—SUMMARY OF FINANCIAL RESULTS SECURED IN COMPARISON WITH THOSE FOR PAST YEARS.

NOTE.—Not to be made retrospective, but to be extended year by year until 10 years are given.

	19 .	19 .	19 .	19 .
Total expenditure on capital account (No. 4) ...	£	£	£	£
Gross receipts from business carried on by the company (No. 8) ...				
Revenue expenditure on ditto (No. 8) ...				
Net receipts of ditto (No. 8) ...				
Miscellaneous receipts net (No. 8) ...				
Total net income (No. 8) ...				
Interest, rentals, and other fixed charges (No. 9) ...				
Dividends on Guaranteed and Preference Stocks (No. 9) ...				
Balance after payment of Preference dividends (No. 9) ...				
Dividend on Ordinary Stock (No. 9) ...				
Rate per cent. ...	%	%	%	%
Surplus or deficit ...				
Appropriation to or from reserve ...				
Brought forward from previous years ...				
Carried forward to subsequent years ...				

(Signed) \_\_\_\_\_ Accountant of the Company.

CERTIFICATES OF THE RESPONSIBLE OFFICERS AS TO THE UPKEEP OF THE WHOLE  
OF THE COMPANIES' PROPERTY.

(Signed for the Board  
of Directors) { \_\_\_\_\_ Chairman or Deputy Chairman of the  
Company.  
\_\_\_\_\_ Secretary of the Company.

AUDITOR'S CERTIFICATE.

As prescribed by Act 30 and 31 Victoria, cap. 127, to follow, substituting Yearly for  
Half-Yearly Accounts.

INDEX.

MAP.

NOTE.—This should be explanatory of the railway system.

SECOND SCHEDULE.

ENACTMENTS REPEALED.

Session and chapter.	Short title.	Extent of repeal.
29 & 30 Vict. c. 108	The Railway Companies Securities Act, 1866	Sections three to thirteen; the words "registered" and "account or statement" in section sixteen, the words "account, statement or" in sections eighteen and nineteen; the First Schedule; the word "registered" (wherever it occurs); and the words "there stated as" and "and registered officer" and the first paragraph of the note in the Second Schedule.
31 & 32 Vict. c. 119	The Regulation of Rail- ways Act, 1868	Sections three, four and five.

## APPENDIX III.

### SCHEDULE TO THE RESERVATION BY MR. ACWORTH, SIR G. PAISH AND MR. PEEL.

#### XIII.—ENGINE-HOURS.

—	Train (including assisting and light).	Shunting.	Total.	Year 19 .		
				Train (including assisting and light).	Shunt- ing.	Total.
Passenger ...	...					
Goods ...	...					
Mineral ...	...					

#### XIV.—CARRIAGE-MILEAGE

Miles run by—					—	Year. 19 .
Passenger coaches ...	...	...	...	...		
Other vehicles on passenger trains ...	...	...	...	...		
Total mileage of coaching vehicles ...						

#### XV.—WAGON-MILEAGE.

—	Loaded.	Empty.	Total.	Year 19 .		
				Loaded.	Empty.	Total.
	Miles.	Miles.	Miles.	Miles.	Miles.	Miles.
Merchandise, &c. ..	..					
Minerals ...	...					
Total ...	...					

## XVI.—PASSENGER-MILEAGE.

To replace XIII in the Schedule of the Report.

Class of Passenger.	Number conveyed.	Passenger-mileage.	Average distance conveyed.	Receipts.	Average receipt per passenger per mile.	Year 19 .				
						Number conveyed.	Passenger mileage.	Average distance conveyed.	Receipts.	Average receipt per passenger per mile.
	No.	Miles.	£	d.		No.	Miles.	£	d.	
1st class ...	...									
2nd „ ...	...									
3rd „ ...	...									
Total ...	...									

## XVII.—TON-MILEAGE.

To replace XIV in the Schedule of the report.

Class of tonnage.	Tons conveyed.	Ton-mileage.	Average distance conveyed.	Receipts.	Average receipt per ton per mile.	Year 19 .				
						Tons conveyed.	Ton-mileage.	Average distance conveyed.	Receipts.	Average receipt per ton per mile.
			Miles.	£	d.			Miles.	£	d.
Merchandise, &c.										
Minerals ...	...									
Total ...	...									

## XVIII.—PASSENGER TRAIN AND CARRIAGE LOADS.

Number of coaches per train-mile—						Year 19 .	
	Passenger ...	...	...	...	...		
Other vehicles	...	...	...	...	...		
Total	...	...	...	...	...		



XVIII.—PASSENGER TRAIN AND CARRIAGE LOADS—*continued*.

		Year 19 .
Number of passengers per passenger train-mile—		
1st class ... ..		
2nd „ ... ..		
3rd „ ... ..		
All classes ... ..		
Receipts per passenger train-mile—		
1st class ... ..		
2nd „ ... ..		
3rd „ ... ..		
Other passenger train receipts ... ..		
Total ... ..		
Number of passengers per carriage-mile—		
All classes ... ..		
Receipts per passenger vehicle-mile...		
Passenger coach ... ..		
Other vehicle ... ..		
Total ... ..		
Number of train-miles per passenger engine-hour ...		

## XIX.—GOODS TRAIN AND WAGON LOADS.

	Merchandise, &c.	Minerals.	Total.	Year 19 .		
				Merchan- dise, &c.	Minerals.	Total.
Wagons per train-mile:						
Loaded ... .. No.						
Empty ... .. „						
Total... .. „						
Average train load (ton-miles per train-mile, revenue tons only) ... .. tons						
Average wagon load (ton-miles per wagon-mile, revenue only):						
Per loaded wagon-mile ... .. „						
Per wagon-mile (loaded and empty) ... .. „						
Train-miles per engine-hour ... No.						
Wagon-miles per engine-hour... .. „						
Receipts:						
Per train-mile (loaded and empty)... .. d.						
Per wagon-mile (loaded and empty)... .. d.						

## XX.--DENSITY OF TRAFFIC.

	Per Mile of Road.	Per Mile of Track.	Year 19 .	
			Per Mile of Road.	Per Mile of Track.
Passenger-miles :				
1st Class ... ..				
2nd „ ... ..				
3rd „ ... ..				
Total ... ..				
Ton-miles :				
Merchandise, &c....				
Minerals ... ..				
Total ... ..				

XVa. in the Schedule of the Report becomes XXIa.

XVb.                   "                   "                   "                   XXIb.

XVI.                   "                   "                   "                   XXII.

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